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ROLE OF EXERCISE IN CARDIAC DISEASE AND EDEMA *

A. A. SUSSMAN, M.D.

BALTIMORE, MD.

The historical side of exercise in cardiology has been reviewed by Bishop.[1] Hippocrates is said to have claimed benefits from baths and exercise in the treatment of heart disease. Aretaios recommended exercises and Galen[2] suggested immersion for dropsy.

Some forty years ago, Schott[3] championed resistance movements, which were commonly employed in conjunction with Nauheim baths. Hirshfelder[4] contended that these exercises are to be regarded as a form of training for hearts with reserve power rather than as a panacea for regenerating a diseased heart already working at its utmost. The pendulum swings to the other extreme. He states that if the patient is not improving under absolute rest, exercises would only increase the work imposed upon the heart and do harm. Mackenzie[5] likewise apparently had little confidence in Schott exercises, stating that fantastic claims have been made.

Oertel's graded exercise treatment was definitely useful and enjoyed considerable vogue on the European continent. It was objectionable because of the necessity for unusually good compensation, and was further characterized by standardization rather than recognition of individual needs with regard to response to effort. Mechanical gymnastics, particularly Zander's method employing various apparatus, likewise enjoyed great popularity. Mackenzie however stresses that for every case of heart affection such exercise involves a mental handicap. Mechanical procedures tend to remind the patient that he is an invalid, while a game, or exercise in the fresh air with an object beyond the consideration of health has a beneficial psychic effect.

In more recent years, many including Eppinger and Hinsberg,[6] have employed exercises with success. These authors reported after the use of peripheral exercises that their patients showed a marked improvement in the general state of health with a particularly favorable change in metabolism. However, they caution that these exercises, which were quite strenuous, should not be employed in the severe stages of heart disease.

Rest, time-honored and proved, is still the basic therapy of cardiac disorders. However experience has shown that prolonged recumbency is a common cause of invalidism in all age groups and particularly in the aged.[7] Harrison[8] after noting atrophic hearts at postmortem of individuals who had been bedridden for months with various debilitating diseases, is likewise of the opinion that rest is often abused. He states further that so long as dropsy is present, the patient should be kept in bed. On the other hand in many cases the edema never disappeared irrespective of the length of rest. In addition the patient becomes progressively weaker, and drug therapy, which in previous episodes of failure has been successful or even hitherto in the present attack somewhat effective, produces less and less favorable response.

Benefits of Exercise

With other factors equal, it is common knowledge that exercise, moderate and regular, and not limited alone to week-end intervals, holidays and vacations,[1] promotes longevity in normal beings by forestalling the development of circula-

* Presented on February 20, 1939 before the staff of the Manhattan General Hospital under the auspices of the Louis Adler Cardiovascular Research Fund, New York City.

tory ailments. Studies on the physiologic effects of exercise in the normal have been reported by Davis[9] and others.

The benefits of exercise in patients without decompensation are those of the normal individual, providing they are carried out within reasonable limits, without the onset or production of pain, dyspnea or extreme fatigue. Relatively little consideration is devoted to the subject. In the main restrictions of varying degrees dominate the picture and frequently to the detriment of the patient. Profound neurosis with a fatalistic attitude becomes a complicating problem in many instances. On the other hand it is difficult to predetermine the amount of exercise that is permissible. Fatigue may be an inadequate guide, because of apprehensiveness of the patient. Vital capacity studies cannot be interpreted on a direct mathematical basis, because of poor physical training or neuro-circulatory asthenia, as pointed out by White.[10]

Exercise should be prescribed not only with careful consideration of the type of heart disease, but also the temperament and general physical training of the patient. Haphazard advice may be translated into exercise, violent and with a vengeance, as if to make up for time lost in the preceding over-occupied years. The picture of the hand-ball enthusiast, troubled with a so-called muscular pain or indigestion, which subsequently proves to be coronary artery disease, is all too familiar.

Physico-Chemical Influences

No effort will be made to enter into a detailed consideration of the causes of edema, except as pertains to the scope of this article. Many points are still controversial. Starling[11, 12] stresses the influence of colloids in edema formation. Alterations in the balanced hydrostatic-osmotic relationship, increased capillary permeability, decrease in the cardiac forward drive and venous return flow, changes in electrolytic concentration,[13] hypoproteinemia, excessive carbohydrate diet, in addition to various other physical, chemical and glandular factors, are of clinical importance.

From the standpoint of the electrolytes, Smith[14] states that organic mercurials alter the acid-base equilibrium in the direction of diminished alkaline reserve of the blood and tissue. It is stated[15] that they increase the chloride content of the blood and the excretion of water, chlorides and the fixed inorganic bases, chiefly sodium, potassium and ammonium. The nearer the approach to a pure cardiac edema, and less the renal or metabolic fault, the greater the chance of ridding the tissues of dropsy by mercurials.

Depletion of the protein content of the blood as a cause of edema in nephritis and cardiac disease has been frequently observed.[16, 17, 18] McClure and Hinman[19] at the Children's Memorial Hospital, Chicago, after extensive experimental studies of edema in protein-starved rats, arrived at conclusions which in the main may be summarized as follows:

1. Lack of vitamin G is not significant as a cause of edema in young rats on a protein-poor carrot diet.
2. The addition to the diet of as small an amount as 0.05 gram daily of a biologically good protein causes some delay in the edema formation.
3. The loss of serum protein in rats with a nutritional edema is more at the expense of serum albumin than globulin as in the human edema.
4. Retention of extracellular fluid in muscles begins with the first loss of serum protein and progresses with increasing hypoproteinemia, arguing against a so-called critical level of plasma proteins for the formation of edema fluid.

Payne and Peters[20] and others found that the decrease in protein content of the plasma parallel the nutritional state of the patient, and therefore attribute the hypoproteinemia to malnutrition. Fishberg[16] adds that considerable albumin-

uria over a protracted period may be particularly significant, where enlargement of the liver possibly interferes with protein regeneration.

In cardiac edema Ellis[21] states that treatment should aim to increase the protein content of the blood and remove excessive lipoids. Increase in plasma protein concentration was noted during recovery from congestive heart failure.[22]

In long standing massive edema of congestive failure there is always a concomitant or secondary renal insufficiency and in addition all metabolic processes will be adversely affected. With progression of the edema, further impairment in function will take place, including a failure in assimilation of food elements, even with a well-balanced diet. This presents a paradox. The edema which is present after four to eight weeks of complete rest, the usual therapy of digitalis, salines and diuretics, including the organic mercurials,[23] will persist until the general physical condition of the patient is improved. Anorexia, dyspepsia, exhaustion and an air of hopelessness dominate the picture. In my experience the only hope of prolonging life and even restoring a small percentage of these cases to activity, although admittedly greatly restricted, is through exercises determined for the individual case.

Exercises for Edema

Exercises may be started during the second week of treatment beginning with simple deep breathing efforts with wide-open windows, followed in about a week with such leg exercises as have been employed in the treatment of peripheral arterial disease, and general massage except varicosed legs. A few minutes of unsupported sitting in the bed, dropping the feet over the side of the bed and finally after eight weeks, even though the edema still be present, the patient is helped out of bed, seated upright in a chair with feet supported on an ottoman or stool. The same principle of postural changes is embodied in the Sanders[24] motorized bed with the added advantage in the latter of avoiding undue fatigue of the patient. Mental as well as physical improvement will be evident.

Concerning the nature of further exercise, resistance movements, simple stretching calisthenics, a few steps of walking about the room — all may be employed.

Standardization is not desirable. It is not a matter of great diagnostic acumen or clinical judgment on one, or a total hit and miss situation on the other hand. Vigilance and intelligence are more important than the character of the exercises. Labored breathing, cyanosis, prolonged tachycardia, a subjective sense of faintness or exhaustion are good clinical guides that exercises have been carried beyond the patient's tolerance,[25] necessitating curtailing the program when repeated or preferably spreading out over a longer period, possibly on a stagger plan.

It is not intended to convey the impression that relief from the edema will be accomplished by exercise alone. Usual drug therapy is employed and high protein,[26] fairly low fat and low starch diet with moderate restriction of salt is recommended. This diet is based on the observations of various investigators as well as favorable responses in my own experience. Animal protein as high as 100 to 150 grams per day is indicated, but the patient's appetite and tolerance will at first render this impossible. Progressively with the improvement in nutrition, a better response to medication will be noted. Nausea is less troublesome and may further be controlled by temporarily substituting for the ammonium chloride a theophylline preparation or dilute hydrochloric acid, which latter may be given in large doses if flavored with honey.

One of the chief benefits of the exercise regimen is an increased desire for food, and treatment may be supplemented by the use of B or other vitamins. Whether or not one accepts as pointed out by many authors[27] definite vitamin

deficiency as a factor in the anorexia and epigastic distress, it is self-evident that some disturbance of nutrition is present. Weiss and Wilkins[28] noted evidences of myocardial failure in two patients with polyneuritis, resembling the "beri-beri" heart in the Orient. The authors are of the opinion that in many of these cases one encounters a diet poorly balanced and deficient particularly in vitamin B. It is of interest to note that war edema, while apparently due to deficiencies in diet, including lack of protein and fat, showed no response to vitamins.[29]

It is conceivable that in long standing cardiac edema, a nutritional form may be superimposed. There may be no deficiency in the diet, but faulty assimilation ascribable to prolonged circulatory disturbance.

Additional aid is obtained by the application of crepe, elastic bandages to the legs, prior to getting the patient out of bed. This probably helps the peripheral circulation. A daily trip in a wheel-chair to an open-air sun porch permitting contact with other patients will result in genuine physical and psychic benefit.

Conclusions

Regular, moderate exercise delays the onset of cardiovascular disturbances in the normal. Judicious exercise as an adjuvant to the usual therapy in cardiac disease helps to restore physical tone and psychic well-being, but unfortunately is a frequently neglected form of therapy. This statement is not to be interpreted as discounting the importance of rest, which obviously is still the basic therapy of anginal and congestive failure. Exercise must be individualized — never employed by the "rule of thumb." Frequently beneficial and occasionally even spectacular responses are noted in obstinate edema. In most patients, life is prolonged and some few will even attain a limited degree of activity, although always requiring observation and treatment.

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RAISING OF VENOUS PRESSURE IN SURGICAL SHOCK BY FARADIC STIMULATION *

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NEW YORK

Many studies have been made concerning the mechanism of that sequence of happenings to which has been given the name of "shock" and even now there is no universal agreement as to its definition, mechanism, and the tissue changes associated with its occurrence. One fact stands out prominently and that is, the collapse of the venous system in shock. The circulation then fails because of a deficient return volume of blood to the right heart.

Henderson's concept of shock and similar allied phenomena (collapse in spinal anesthesia, toxemic depression) is based on such a venous system collapse with circulatory failure. Henderson conceived a venopressor mechanism based in part on the tonus of the tissues. The increased tone in the tissues prevents blood stasis by compressing the capillaries. When this tone diminishes the blood accumulates and stagnates in the venous reservoirs, that is, the capillaries. Henderson furthermore believes that the respiratory center exerts an indirect but important control of the venopressor mechanism.

For the demonstration of the importance of tissue tone in regard to venous circulation he discusses the experiment of Riml which he had repeated and confirmed. The thorax of a cat in deep narcosis is opened. The pulmonary artery is clamped off which immediately brings the circulation to a standstill. A trocar is then thrust into the right ventricle of the heart. Half or more of the blood of the animal gushes through the trocar under a pressure equivalent to a column of water of 10 to 12 cm. It is pointed out that inasmuch as the clamping of the pulmonary artery brings the circulation to a complete stop, the flow of half the blood of the animal must come from the blood reservoirs in the tissues. It is tonus in the tissues which pushes the blood toward the heart. As Henderson states it: "The pressure is produced within the tissues and is due to their tonus; for it disappears along with their tonus a few minutes after death. Muscle tonus is therefore the force that produces this pressure and with it a flow of the blood through the veins to the heart." Thus the underlying failure of circulation in shock is due to a lack of venous return. The heart can only pump into the arterial circulation what it receives from the right heart and the small amount of oxygenated blood pumped from the left heart into the arterial system is too little for the needs of the body tissues. Thus there is the development of anoxemia and its train of symptoms called shock.

In a similar manner the injection of an anesthetic into the spinal canal may not only affect the sensory roots of the cord as is intended but unfortunately may reach the motor roots and paralyze them as well. The inhibitory effect of the motor centers on the tonus of the skeletal muscles

* Read at the Eighteenth Annual Session of the American Congress of Physical Therapy, New York City, September 6, 1939.

results in a diminished venous return to the right heart with a resultant diminished cardiac output and finally, failure of arterial pressure, anoxemia and shock. Thus failure of circulation in spinal anesthesia resembles very closely the picture of shock and occasionally costs a life.

The above impressions of Henderson are supported by the investigations of Gollwitzer-Meier and forty other investigators and the work of Schuberth. The latter comes to the conclusion that "shock or collapse is essentially a peripheral circulatory collapse" and also concludes that in spinal anesthesia "the decreased cardiac output depends not upon heart failure, but upon an impaired venous return to the heart. The cause of the circulatory disturbance lies in the periphery."

Smith, Rovenstine and Goldring, in a study of 18 subjects in which sensory anesthesia was established up to T 5 and 3 to above T 1, came to the following conclusion:

"Normal blood pressure may be maintained in normal unoperated subjects with sensory anesthesia in spinal levels T 5 or higher above those at which the highest vasoconstrictor fibers emerge to the splanchnic viscera and legs. In those instances in which the arterial pressure is reduced, the systolic pressure falls more than the diastolic, the latter being usually maintained at essentially normal levels. There is at no time the hemodynamic picture to be expected from arteriolar dilatation, rather the decrease in blood pressure is such as is to be expected in consequence of a decreased cardiac output in the face of an unchanged arteriolar bed. That the cardiac output is actually decreased is indicated by measurements available in the literature. Thus a decreased cardiac output results from decreased stroke volume, the latter resulting from post-arteriolar dilatation and decreased venous pressure. The post-arteriolar dilatation can be explained in terms of dilatation of capillaries, venules, and veins in consequence of skeletal muscle paralysis without tonic sympathetic activity to these circulatory channels. Possibly some further venous embarrassment is occasioned by paralysis of the abdominal and thoracic muscles and in some instances by acute dilatation of the spleen."

In general anesthesia, where muscle tonus is not lost, the venous pressure is little changed and most often rises. In chest surgery (34 cases of thoracoplasty) Coryllos and Standard found that in 34 patients 9 had no change in venous pressure, neither increasing or decreasing, in 21 patients there was a rise of venous pressure on the side of the operation, and in 4 patients there was a bilateral rise of venous pressure. This is in marked contrast to what occurs to venous pressure with hypotonia of skeletal muscles. Thus we have considerable evidence of the close association of hypotonia and variable conditions of shock which, when extreme, may be the cause of death.

Technic of Faradic Contractions

Based on Henderson's concept of venous pressure collapse and its close association with hypotonia of the skeletal muscles, the authors conceived the thought of producing a contraction of large areas of skeletal muscles to force the stagnant capillary blood out of the muscles back into the venous circulation and in that manner stave off circulatory failure. Skeletal muscle contraction was accomplished by electrical stimulation (Ornstein, Licht and Herman). The faradic current was chosen because its effect resembles most nearly a normal contraction and it is much less painful and shocking than the galvanic current. To prevent fatigue, we thought it important to interrupt the current flow, and to prevent exhaustion, we would discontinue excitation after ten minutes, allowing a ten minute rest period.

The apparatus we used consisted of a wall-plate type of faradic coil with a ribbon interrupter, and a tapped secondary coil of five thousand turns. The house current was supplied to the primary through a flasher socket fitted with a fifty watt lamp, which gave a fixed rhythm of about thirty

impulses per minute. With so simple a set-up, either alternating or direct current can be used. A more fool proof apparatus has been built to our specifications by the American Cystoscope Company, which they call the "Faradyne." This is a small portable unit in a light (13 pounds) carrying case which can be plugged into any 110 volt alternating current house socket.

The advantage of this unit is that it is ground-free, shockproof, and avoids the possibility of any injury resulting from overdose, because the internal resistance of the patient circuit automatically limits the milliamperage. Further, the mechanical interruption of the current is in an explosion-proof capsule, permitting its use where an open spark such as that used in the faradic coil might be dangerous.

The current is produced through the use of a gas filled triode. The plate voltage is applied through a condenser-resistance combination having the desired "time constant." This determines the length of time required to build up the plate voltage to the point at which the grid loses control and permits the tube to conduct. At this point the condenser discharges through the tube reducing the plate voltage almost instantaneously to zero. The grid then regains control, the tube ceases to conduct and the cycle then repeats, the frequency being determined by the above-mentioned "time constant" of the condenser-resistance combination. The triode is fed with rectified, filtered alternating current.

The voltage is fixed at 500 volts, the frequency at 1,000 cycles per second, and the intensity may be varied from zero to 15 milliamperes. It will be found that 10 milliamperes is sufficient to cause adequate contractions in most patients.

Towelling was soaked in physiologic saline solution and wrapped around the lower abdomen and corresponding portion of the lower lumbar and gluteus muscles of the patient in six layers, to allow for universal contact and the adequate retention of moisture. A belt electrode of block tin, six inches wide and fifty inches long was then secured about the towels with a clip, and the belt was then connected to the secondary of the faradic coil through an eight foot insulated cable. Each lower extremity was then encased in the same manner as the abdomen and electrodes four inches wide and fifty inches long were wrapped about them in legging-fashion. Both of these electrodes were connected to the other secondary terminal.

When using the faradic current, the secondary coil was set to its minimum output and the current turned on. If the intensity is not sufficient to cause marked contractions, the output is increased by closing the coupling very gradually until the contractions are marked but not painful.

It is important that bare metal does not touch the skin, because burns may result if it does. Only the lower half of the abdomen must be stimulated so that there will be no interference with free breathing.

The venous pressure was estimated by the direct method because of its ease, accuracy and reliability. This procedure depends upon the cannulation of a vein and the free flow of sterile sodium citrate solution into it until the pressure in the vein counterbalances the column of fluid in the manometer.

The patient is placed flat on his back, after a preliminary basal rest of at least fifteen minutes. The level of the right auricle is then determined by taking a point in the fourth intercostal space five centimeters behind the sternum. The arm of the patient is raised to this horizontal plane and the manometer, which is capable of being adjusted, is fixed with a zero reading at the same level. In this way the level of the right auricle (taken to be zero), the arm vein and the manometer coincide. A three-way stopcock is

connected to (1) a syringe, (2) a manometer and (3) an 18 gauge caliber needle one inch long.

Two and one-half per cent sterile sodium citrate is put into the manometer at about the level of fifteen centimeters. Citrate is also present in the needle and syringe. The needle is then inserted into the vein and communication with the manometer is established.

If the pressure in the vein is less than that of the fluid in the manometer, the fluid level will fall until both pressures are equal. On the other hand, if the vein pressure is higher than that of the fluid in the manometer, the latter will rise until the equilibrium is found.

With the venous pressure thus taken, the patient is stimulated with a faradic current. At frequent intervals venous readings are made. This can be continued for periods as long as one hour by simply washing through the needle, occasionally, with citrate from the attached syringe.

Clinical Studies

Using the above described technic we subjected a group of 41 persons to faradic muscle stimulation and measured the venous pressure before and after. The subjects used were tuberculous patients at Sea View Hospital and also a small number of the residential medical staff. The normal venous pressure in this group varied from a low of 4.5 cm. of water to a high of 20 cm. of water. Following faradic stimulation there was a venous pressure rise of 1.4 cm. of water in one person (the lowest rise) to a venous pressure rise of 10 cm. of water, which was the highest increase. The average rise in venous pressure was 3.57 cm. of water pressure (table 1).

From the above we knew that we could raise the venous pressure by faradic stimulation of a large surface area of skeletal muscles. We then turned our attention to its clinical application in shock. At Sea View Hospital with the development and progress in thoracic surgery, surgical shock is a rare occurrence. We therefore had to go to other hospitals for the clinical application of this method of re-establishment of circulation by faradic stimulation of skeletal muscles. One hardly realizes the difficulties in obtaining suitable clinical material for the treatment of shock. For example, Dr. Breidenbach, who has been interested in the treatment of surgical and traumatic shock agreed to use the above method of therapy in such cases. During June, July and August, Breidenbach and his associates investigated 47 patients of traumatic injury brought to Bellevue Hospital for treatment. Unfortunately, in this group there was not one case of traumatic shock, or we may say that in a few, shock was suspected but the symptoms were so mild that no faradic stimulation was given and in all these patients there was no development of real shock. Therefore the authors must again refer to the one case of shock which they reported in their publication of April, 1938. The patient was admitted to St. John's Hospital. He was a white male, 32 years of age, who was in an automobile accident and sustained a fracture of his right tibia. When brought into the hospital he was in shock. The outstanding features were profound apathy; he paid no attention to what was going on about him; his skin was cold, clammy and grayish in color; the breathing was characterized by periods of long sighing respiration. Venous pressure was 2 cm. of water, blood pressure 80/?.

Faradic stimulation was applied for three-quarters of an hour. The venous pressure rose progressively to 10 cm. of water and the blood pressure rose to 95/60. The sensorium cleared and the patient was considered clinically to have recovered from shock.

TABLE 1. — *Venous Pressure Studies in 42 Cases*

Case No.	Age	Sex	Before Stimulation	After Stimulation	Increase in Venous Pressure
1	26	male	17.5	22.0	4.5
2	27	male	10.0	15.5	5.5
3	26	male	16.0	19.5	3.5
4	26	male	15.5	17.5	2.0
5	27	male	17.0	19.5	2.5
6	22	male	7.5	12.0	4.5
7	35	male	7.5	10.0	2.5
8	20	male	9.5	12.0	2.5
9	19	male	8.4	11.6	3.2
10	38	male	16.4	17.9	1.5
11	33	female	20.0	23.0	3.0
12	28	male	7.5	12.4	4.9
13	27	male	8.4	10.2	1.8
14	32	male	15.6	17.8	2.2
15	31	male	8.8	12.2	3.4
16	31	male	7.2	12.5	5.3
17	31	male	6.4	10.6	4.2
18	34	female	5.2	10.0	4.8
19	18	male	6.5	12.2	5.7
20	21	male	6.0	8.4	2.4
21	27	male	12.0	17.0	5.0
22	27	male	15.0	18.5	3.5
23	24	male	5.0	7.2	6.2
24	28	male	14.0	24.0	10.0
25	29	male	8.2	10.5	2.3
26	33	male	6.4	10.0	3.6
27	18	male	5.2	7.8	2.6
28	26	male	5.2	9.2	4.0
29	25	male	4.5	8.0	3.5
30	26	female	8.8	10.2	1.4
31	25	male	10.0	12.0	2.0
32	29	male	11.4	13.2	1.8
33	36	male	12.4	14.6	2.2
34	20	female	7.0	8.9	1.9
35	30	male	6.4	10.0	3.6
36	36	male	12.5	14.4	1.9
37	39	male	13.6	18.0	4.4
38	34	male	7.6	10.2	2.6
39	....	male	10.2	15.4	5.2
40	....	male	5.8	9.8	4.0
41	....	male	9.4	12.6	3.2
42	....	male	7.0	12.0	4.0
Average			9.86	13.45	3.57

Comment

First, we note that venous pressure is low in shock, 2 cm. of water, just as Henderson believes. Secondly, we note that the blood pressure is also low, a systolic of 80 mm. mercury and no diastolic pressure. With faradic stimulation of the skeletal muscles for three-quarters of an hour the venous pressure rose to 10 cm. of water and the systolic arterial pressure to 96 mm. of mercury and the diastolic from zero to 60 mm. of mercury. The patient had recuperated from what was diagnosed as shock.

It is most unfortunate that we have not had more clinical cases of shock to treat. The experience would have been of utmost importance with a European war in progress. This method of prevention of shock may play a most important role in cutting down the high toll in deaths caused by war wound shock.

The failing circulation in spinal anesthesia caused by the hypotonia of the skeletal muscles is helped by faradic stimulation. Here we have had sufficient cases to state that the fall of venous pressure may be alleviated

by faradic stimulation. The cases treated have not been in real shock but in that condition following the injection of anesthetic into the spinal canal where both the sensory and motor roots are paralyzed, with marked hypotonia of the involved skeletal muscles. The venous pressure then falls rapidly and the symptoms and low arterial pressure resemble a state of shock. In these cases there has been evidence of the value of faradic stimulation in raising the venous pressure.

Summary

The authors do not wish to make any definite conclusions from such scant material. We do know that faradic stimulation of large areas of skeletal muscles will raise the venous pressure, and if the concept of shock, which the physiologists associate with collapse of the venous system and with hypotonia of skeletal muscles, is correct, the above simple method of raising venous pressure may be of considerable help in the treatment of all forms of shock.

This paper is presented before this Congress to acquaint its members with another use of faradic stimulation. It is the hope of the authors that this method of raising venous pressure will be brought to the attention of the surgical staffs of all the hospitals this Congress represents, so that the very occasional case of shock which occurs here and there may be so treated and the reports of the success or failure of this treatment may at a future time give us the knowledge whether or not the cause of shock has been overcome.

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Discussion

Dr. Kenneth Phillips (Miami, Fla.): For several years I have felt that clinical shock was associated with venous collapse. During this time I have advocated that the first principle of therapy should be restoration of venous blood volume rather than cardiovascular stimulation.

Totally unknown to each other, the authors and myself have been thinking along identical lines in respect to types of physical therapy in this shock syndrome. Interesting enough, we have been using the slow interrupted galvanic current, attempting to obtain the same results as they have obtained with the faradic.

Our technical set-up has been to use a large pad in the center of the back high up attached to one terminal, and to the other a forked electrode terminating into smaller pads under the calf of each leg. Our work is so new and preliminary in nature that we do not offer it as being in any way conclusive, but only as a relation to the theory propounded and the well-controlled results obtained by the essayists. May I ask if in the opinion of the essayists the interrupted galvanic current would do equally well for those not equipped with the faradic apparatus?

Dr. Edwin Hirsch (Rockville Center, N. Y.): I have had an opportunity to discuss this problem with Dr. Licht. I have been very much interested in this work, but have not been very successful in getting the opportunity to apply it. I would like to ask whether this method could be applied in any other type of peripheral vascular collapse.

Dr. George Ornstein (New York): I would like to again point to the fact that the fundamental knowledge in shock on

which we made our contribution was based on the work of Yandell Henderson. In regard to Dr. Phillips' question as to whether faradic or galvanic stimulation was best, I am not able to answer the question. The choice of electrical stimulation was left to Dr. Licht who has been trained in physical therapy. Dr. Licht's choice was the faradic current, because it is the least painful of the two methods. I imagine there must be many other methods to stimulate muscle contraction.

AUTOHEMOTHERAPY COMBINED WITH ARTIFICIAL FEVER *

Further Observations in the Treatment of Rheumatic Disease

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In a previous report, the effects of autohemotherapy on various types of rheumatic disease were reported. In the same report it was concluded that the effects of autohemotherapy could be greatly enhanced by the use of artificial fever. It was found that the combination of the two was of much more benefit than when either was used singly, consequently this combined therapy was applied to various types of rheumatic disease in order to study the reaction. In this discussion, the results obtained in the first report will be reviewed, and observations made since that time will be added.

The technic which has been employed is as follows:

Ten cc. of blood are withdrawn from the patient's vein and injected deep into the hip muscles before clotting takes place. This is followed immediately by one hour of artificial fever at 101 F. This procedure is repeated twice weekly for eight to ten treatments; then discontinued for two to four weeks. The series is then repeated as indicated.

Technic

In arriving at our present technic of administering fever many methods were used and varying degrees of temperature reached. For the past eighteen months, the following technic has been employed. The patient is allowed a regular, normal meal one hour prior to the treatment. Ten grains of sodium chloride are given along with as much water as is desired about fifteen minutes before the treatment is to begin. In view of the fact that a relatively low fever level is to be reached, we use a very simple method of elevating the temperature. All fever rooms are air conditioned to a temperature of 79 F. and a relative humidity of 45 per cent.

We use a short wave diathermy apparatus of the inductance cable type, utilizing a frequency of 15,000,000 cycles per second (12 meters) in the following manner. A fever bed is prepared by using a wooden table covered with a cotton mattress of average bed thickness. Over this mattress is placed the inductotherm cable arranged as a loop. A cotton pad, three inches thick, covered with a bed sheet is then placed over the cable. Upon this founda-

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tion two units are placed. First, a "dry" bed, consisting of a blanket and sheet which are folded fan-wise and are to be used later, after the patient has attained the designated temperature and has returned to 99 F. Over the folded "dry" unit is placed the "wet" unit. This consists of a woolen blanket, rubber sheet, cotton sheet, and then a sheet of turkish toweling. The patient is placed in a long sleeved cotton gown and lies on the toweling sheet. The sides of this "wet unit" are caught up together and placed over the patient; one lapped over the other, with the ends folded over the feet and about the head and neck.

The inner sheet soon becomes wet with the patient's sweat. Originally we dampened this sheet before the treatment was started, but soon found this to be unnecessary as a sufficiently high humidity was easily maintained by natural means. In the last 500 sessions given, an average of 55 minutes was required to reach 101 F. It is our practice to discontinue the current at this temperature and we have found that it continues around 101.5 F. A temperature of 101 F. is maintained for an average of one hour. The patient is then allowed to cool normally. Usually it requires one and one-half hours to return to 99 F. At this point, the folded "dry unit" is drawn over the wrapped patient and the "wet unit" is removed by slipping it over the feet. The patient remains in the "dry unit" until the temperature returns to normal. Usually this requires thirty minutes. Normal activities may then be resumed as there are no untoward symptoms following this mild procedure.

A total of 308 patients with rheumatic disease have been treated in the series and the results are shown in table 1. From this table it is evident that while autohemotherapy or artificial fever at 101.5 F. for one hour, when used singly, is of definite value in the treatment of rheumatic disease, the combination of the two is more efficacious.

TABLE 1.

		Autohemotherapy Plus Artificial Fever 101.5 F. Unless Marked.			Autohemotherapy Only			Fever Only			Totals		
		Complete Remission	"Improved"	No Response	Complete Remission	"Improved"	No Response	Complete Remission	"Improved"	No Response	Complete Remission	"Improved"	No Response
Acute Infectious Arthritis	22	13	1	2	5	0	1	0	0	0	18	1	3
Acute Fibrositis	36	23	0	0	9	1	0	2	1	0	34	2	0
Acute Gouty Arthritis	4	2	1	0	0	0	1	0	0	0	2	1	1
Rheumatic Fever†	22	1	1	0	0	0	0	15	5	0	16	6	0
Juvenile Arthritis (Still's Disease)‡	11	9	0	0	0	0	1	0	1	0	9	1	1
"Premenstrual Rheumatic Exacerbation" Syndrome	50	8	1	0	31	9	1	0	0	0	39	10	1
Acute Gonococcic Arthritis	11	7	0	0	3	1	..	0	0	0	10	1	0
Menopausal Arthralgia —													
With *Estrin	29	12	1	2	12	2	0	0	0	0	24	3	2
Without Estrin	7	2	1	1	2	2	0	0	0	0	4	3	1
Chronic Fibrositis	71	42	3	0	6	4	0	14	0	2	62	7	2
Chronic Infectious Arthritis	44	1	12	9	2	9	8	0	1	2	3	22	19
Totals	308	120	21	14	70	28	12	31	8	4	221	57	30

* 1.0 mg. in oil given twice weekly.
† Fever used in these cases reached 103 degrees for 3 hours. I. V. Typhoid used.
‡ Fever used in these cases reached 103 degrees for 1 hour. I. V. Typhoid used.

When analyzed, the results shown in table 1 are very encouraging in certain types of rheumatic diseases. The best results are found in the group including acute phenomena. Of the 23 patients diagnosed as acute "fibrositis," all had complete remissions when given combined autohemotherapy and artificial fever. When autohemotherapy alone was used, 10 per cent failed to have a complete remission. When fever alone was used, 33 per cent failed to respond completely. Of the 7 patients diagnosed as acute gonococcic arthritis who received the combined autohemotherapy-fever management, all had complete remissions, while 25 per cent of those receiving only autohemotherapy failed to respond. In the group diagnosed as acute infectious arthritis, it must be remembered that it is very difficult to arrive definitely at this diagnosis. As pointed out by Slocumb the difficulty of diagnosis does not permit accurate interpretation of results. This same reservation should be held for the group classed as acute gouty arthritis.

Of the chronic types of rheumatic disease treated, juvenile arthritis (Still's disease) and those classed as "fibrositis" responded most satisfactorily. In the juvenile arthritic group nine patients received autohemotherapy followed with 103 F. fever for one hour. All of them had complete remissions. The fever in this instance was provoked with intravenous typhoid vaccine. One patient was treated with autohemotherapy only and showed no improvement. One patient was treated with fever only and showed only a moderate improvement. This group needs a larger and more complete control series.

The group classed as "menopausal arthralgia" includes those women whose rheumatic symptoms followed a natural or artificially produced menopause. The use of the estrogenic substances in these cases has been very ably set forth by Hall and the effect of autohemotherapy and fever used in conjunction with this treatment was discussed with that author. As is indicated in table 1, the addition of 10,000 units of estrogenic substance greatly increased the efficiency of the autohemotherapy and fever. This suggests the possibility of the addition of some substance to those types which do not respond to autohemotherapy and fever.

One of the most interesting responses was seen in that group termed chronic "fibrositis." Here again, the question of diagnosis is important. In this group 42 of the forty-five patients receiving the combined therapy had complete remissions, an average of 93.3 per cent, while there were three "improved." Of the 10 patients receiving autohemotherapy only, 6 had complete remissions and 4 were improved. Sixteen of the group received the fever only and 87 per cent of these had complete remissions while 13 per cent failed to show any response.

Forty-four patients diagnosed as chronic infectious arthritis were included in the series, 22 receiving the combined therapy, 19 the autohemotherapy alone, and 3 the mild fever sessions only. Of the twenty-two patients receiving the combined therapy, 4.5 per cent had a complete remission, 54 per cent were improved and 41 per cent showed no improvement. Of the nineteen patients receiving autohemotherapy only 10 per cent had complete remissions, 47 per cent were improved and 43 per cent failed to respond. Of those patients receiving fever only, one was improved and two failed to respond.

The group classed as "Premenstrual Rheumatic Exacerbation Syndrome" is a mixed one which includes those women who have rheumatic pains 3 to 5 days prior to each menstrual period. In these cases, the autohemotherapy was given every other day for 10 days prior to the expected onset of the menses. Of the 40 patients receiving autohemotherapy alone, 31 were

completely relieved, 9 were "improved" and one failed to show any response. When the artificial fever was added in a group of 9 patients, 8 responded completely and one was "improved."

In the patients diagnosed as rheumatic fever, only two patients received the combined therapy. One of these had a complete remission and one was "improved." Twenty received intravenous typhoid fever therapy at 104 F. for 4 hours repeated twice weekly; fifteen having a complete remission and five being "improved."

Discussion

Autohemotherapy is not a new procedure and has long been employed for a large variety of diseases. Work is now being done to study its effects but at the present time, one effect is apparent — desensitization. Its effect on urticaria, serum sickness, various dermatoses and other allergic phenomena is well known, but the entire role it plays in rheumatic diseases cannot be fully deducted at this time. The allergic nature of rheumatic disease has never been clearly established.

The effects of artificial fever need not be discussed at this time, but it is evident that when a relatively low level of 101.5 F. is reached, the chief effect would be that of a physiologically increased metabolism. This most likely would have the effect of reinforcing the reaction of autohemotherapy in addition to the usual effect brought about by the low grade fever.

Conclusions

From the data available at the present time, I have concluded the following:

1. Autohemotherapy combined with 101.5 artificial fever for one hour is of definite value in the treatment of the following types of rheumatic disease: (a) acute fibrositis; (b) chronic fibrositis; (c) acute gonococcic arthritis; (d) juvenile rheumatoid arthritis (Still's disease), which requires a temperature of 103 F. for one hour; (e) acute infectious arthritis; (f) "Premenstrual Rheumatic Exacerbation" syndrome, and (g) the effect of estrogenic materials, when used in the treatment of menopausal arthralgia is fortified and protracted.

2. The above procedure is of little or no consistent benefit in chronic infectious (rheumatoid) arthritis (adult form).

3. This procedure is simple and safe. It utilizes two methods of treatment which, when combined, add greatly to our armamentarium of rheumatic disease. This management, even when successful does not replace the common sense, supportive measures indicated in all cases and does not eliminate the necessity of a thorough clinical, laboratory and x-ray examination with elimination of etiologic factors.

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(For discussions, see page 342)

TREATMENT OF ATROPHIC ARTHRITIS WITH ARTIFICIAL FEVER THERAPY *

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and

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The therapeutic value of heat for the relief of muscle and joint disorders has been known since ancient times. Barbaric and semi-civilized peoples employed natural hot springs and devised various types of sweat baths for the treatment of these diseases. Artificial fever therapy of arthritis is a natural development of the healing art which had its origin in remote ages. Artificial fever therapy produced by the intravenous injection of bacteria, the inoculation of foreign protein or physical means has been employed for various types of arthritis. We have already reported our results obtained by fever therapy in gonococcic and in acute infectious arthritis of undetermined origin. The present report is concerned with the results obtained by artificial fever therapy with the Kettering hypertherm, in 114 patients with atrophic arthritis at City Hospital during the last five years.

Atrophic arthritis is the most interesting, the most important and the most disabling of the common joint diseases. It is of great economic importance because of the long period of disability which it causes. Satisfactory methods of prevention or cure have thus far not been discovered. It is a chronic disease characterized by multiple joint involvement, impairment of general health and an interruptedly progressive course leading in many cases to complete disability. Women are afflicted more commonly than men. The onset frequetly occurs between the ages of 20 and 40, usually in an

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insidious manner. Any joint may be affected, multiple joints are involved in individual cases with fusiform swelling, pain, limitation of motion and finally ankylosis. The joints usually seem to be only moderately inflamed as judged by the degree of redness or heat. As the disease progresses, joint destruction occurs resulting in deformity and ankylosis which persist even during periods of remission.

TABLE 1. — *Duration of Disease*

Less than 1 year	9	10 to 15 years	13
1 to 5 years	52	More than 15 years	11
5 to 10 years	29		

This report includes all of our patients with atrophic arthritis who received treatment in the Kettering hypertherm. Analysis of this group reveals that it includes a high proportion of patients with severe atrophic arthritis of long duration. Fifty-three, or 46.5 per cent, had had atrophic arthritis 5 to 20 years; fifty-two, or 45.5 per cent, had had the disease 1 to 5 years, and only 9 patients, or 8 per cent, had had symptoms for one year or less. This information is presented in detail in table 1. The age distribution of this group is higher than one ordinarily associates with atrophic arthritis, a natural effect of the long duration of disease experienced by so many of the patients. Table 2 presents the age distribution by decades. It

TABLE 2. — *Age Distribution*

Age	Numbers	Age	Numbers
1- 9	1	40-49	37
10-19	1	50-59	21
20-29	25	60-69	1
30-39	28		

will be noted that more than one-half of the patients were at least 40 years of age when treated and about one-fifth of them were over 50 years of age.

TABLE 3. — *Patient's Joint Involvement*

Number of Patients	Joint	Limitation in Motion	Deformity
107	Knee	88	14
98	Fingers	62	19
81	Wrist	59	14
79	Ankle	64	11
69	Elbow	66	5
67	Shoulder	48	....
50	Hip	42	1
28	Toes	19	14
27	Spine	15	2
11	Jaw	8	....

Table 3 indicates quantitatively the joints involved. The first column reveals the number of joints involved. Column 2 indicates the number of joints with limitation of motion, and the last column reveals those joints with permanent deformities. The knees, fingers and wrists were most commonly affected.

As a rough estimation of the functional activity of these patients, they were classified according to their ability to get around at the time that fever therapy was started. Thirty-five patients, or 30 per cent, were wheel chair or bedridden invalids, 15 others, or 13 per cent, were ambulatory with the

aid of crutches or canes, and only 64, or 56 per cent, were ambulatory without aid.

We gave 1,232 treatments, totaling 3,869 hours of therapeutic fever. The patients received an average of 34 hours of fever. The number of treatments for individual patients varied from 1 to 60.

Rectal temperatures of 103 to 104 F. were maintained for 3 hours. The usual precautions to replace water and salt loss were employed and sedation with sodium amytal, morphine or pantopon was used in most cases. Because of the short duration and moderate elevation of the fever, treatments were well tolerated and complications were rare. Higher fevers of longer duration for atrophic arthritis were abandoned early in our experience because of the severe debility and subsequent loss of appetite without additional therapeutic benefit.

The immediate effects of fever therapy in our group were encouraging and often striking. Complete relief was noted in only 2 patients of this series. Partial relief was obtained in 85 patients or 75 per cent. This relief included definite decrease or abolition of pain and stiffness and increase in range of motion of affected joints. Swelling was not immediately influenced to the same extent as were the above factors. Doubtful relief or no relief whatever was observed in 26 patients or 25 per cent. In many of these patients the degree of relief was so slight or the duration of relief so short as to render the therapy impractical.

The final results obtained were not as satisfactory as were the immediate effects. The final results were determined by the condition of the patients when last seen. The period of observation varied from 6 months to nearly five years. The patient's condition on discharge or when last seen was found to be unchanged in 93 cases or 82 per cent. In 11 individuals it was thought to be improved, in 10 it was definitely worse.

The final results observed in the entire group were not encouraging. In asmuch as this might be due, in part at least, to the large proportion of severe cases of long duration, it seemed desirable to analyze the results obtained in the early cases. Of the 9 cases with atrophic arthritis of less than 1 year's duration all were ambulatory when first seen. When last seen, only 7 were ambulatory, 1 was ambulatory with crutches and one had become a wheel chair invalid. Five were considered to have had partial relief, 2 had doubtful or no relief, and 2 were definitely worse.

Comment

A review of our experience shows that artificial fever therapy failed to cure a single case of atrophic arthritis. It may further be said that this treatment failed to permanently arrest the disease. This does not mean, however, that artificial fever therapy is totally without benefit to patients with atrophic arthritis. Fever therapy gave partial relief of pain and stiffness in 85 patients, or 75 per cent. At times relief persisted for only one or two days but it occasionally continued for several weeks. Subsequent treatments frequently were disappointing to the patients because improvement was no greater than that obtained after the first one, but when treatments were repeated the duration of benefit became prolonged. As a result of this effect the time interval between treatments could be lengthened without deleterious effect and a partial remission was effected. The disease in several patients has attained such a degree of stability that only three or four treatments a year are necessary to keep the patients relatively comfortable and active.

Atrophic arthritis characteristically produces damage and destruction to joints of such a nature as to seem utterly irreparable. Effective therapy should prevent permanent joint changes if applied sufficiently early in the disease or should prevent further progress of such changes which are already present. Effective therapy should also eliminate joint inflammation, provide restoration of general health and prevent exacerbations of the disease. Such ideal objectives are not now attainable in a satisfactory proportion of cases of atrophic arthritis by any known method of therapy. Certainly artificial fever therapy does not accomplish them. Until the specific nature of the disease is recognized, symptomatic treatment is the best we can offer. This includes physical and emotional rest, an adequate and well rounded diet, proper elimination of waste products and the relief of joint pains by medication and physical therapy. The results obtained from the use of various kinds of streptococcal vaccines, bee venoms and sulphur preparations have been disappointing in the majority of cases in our experience. Gold therapy is highly recommended at the present time but seems to incur certain undesirable hazards.

The present study indicates that artificial fever therapy is not a cure for atrophic arthritis. It does not secure permanent relief of symptoms nor does it promise substantial increase of joint function or bodily activity to the patient. Artificial fever therapy does offer a greater degree of temporary relief of joint pain and stiffness than any other therapy with which we are familiar. This relief is sufficient to warrant the use of this form of treatment in selected cases.

Discussions of Papers of Drs. M. B. Ferderber; W. M. Solomon and R. M. Stecher; W. K. Ishmael; H. W. Kendell, *et al.*;* E. Belt and A. Folkenberg;** A. E. Bennett, *et al.*;** E. C. Elkins and R. L. Bennett, Jr.*

Discussion

Dr. Kenneth Phillips, (Miami, Florida): One year ago, I found Schmitt in Chicago obtaining very encouraging results with prolonged penetrating heat in certain types of sacroiliac and back conditions. Our experience during the past year has confirmed its value. The question might be raised as to the effect of general anaesthesia upon the experiments carried out by the author. Also, was the red blood count checked along with the white count in order to estimate the amount of change being due to dehydration?

In the beginning of fever therapy by physical means, I believe we all had hoped that it would prove to be of great value in atrophic arthritis. Personally, I had further hoped that Drs. Solomon and Stecher might have found some technic by which this might come true. Our experience in about 47 cases has been very discouraging through a failure in approximately 97 per cent. I should like to ask the essayists if the clinical improvement in the way of symptoms is sufficient, in their opinion, to make it worth while to use fever therapy?

Dr. Ishmael's paper interests me very much. We have used autohemotherapy alone and fever therapy alone in the various rheumatic and arthritic syndromes and our results have been rather disappointing. Certainly they would indicate that in the combination of both we might step up the efficiency similar to combined chemo-fever therapy in other diseases. I should like to ask the author to explain his reason for giving the two so close together? Why wouldn't better results be obtained by either preceding the fever, possibly twenty-four or even thirty-six hours with the blood, or else give the blood at the close of the fever session? The aim would be to gain a more prolonged reaction.

The transactions of the first International Fever Congress held about four years ago reveal that I made a plea for clinical research in the direction of attempting to accomplish the desired results at lower temperatures and shorter duration. For the past three years, we have stressed the value of technic and pre-fever management together with the unsafety of improperly trained personnel. I am happy

* Papers of Drs. A. E. Bennett, *et al.*, and H. W. Kendell, *et al.*, appeared in the October, 1939 issue of the ARCHIVES.

** Papers of Drs. E. Belt and A. Folkenberg, and E. C. Elkins and R. L. Bennett, Jr., appeared in the April, 1940, issue of the ARCHIVES.

to see these opinions confirmed by Drs. Kendall and Simpson.

The single long fever session for gonorrheal infections, undoubtedly, has its advantages, especially economically. However, I personally experience difficulty and feel concerned as to its safety. For many departments not well equipped, it is highly probable that the more practical technic is the shorter maintenance periods even though more treatments are required. Quantitative blood studies in the management of syphilis stressed by Dr. Kendell is a most valuable aid. After using it for a time, one feels completely lost without it. We have utilized the Kline in place of the Kahn reaction and find it very satisfactory.

A year ago we heard an opinion from the floor of this Congress to the effect that, since the advent of sulfanilamide, fever therapy was on the wane in so far as the treatment of gonorrhea was concerned. Many of us did not concur in that opinion, and the splendid report of Drs. Belt and Folkenberg reveals the definite clinical value of their combination. Our experience in this field closely parallels that of the authors, but one should not overlook the problem of safety in carrying out these treatments in the office. I am certain that these authors only advocate "office fever" when an office is properly equipped in personnel and apparatus.

Our technic is essentially the same as theirs except that we have experienced some undesirable reactions when large doses of sulfanilamide were given on the same day as the fever. We, therefore, withhold the drug on this day until after the fever session. The incidence of cure in our series of 115 cases was 92 per cent, or slightly higher than that of these workers.

The opportunity of which Dr. Bennett and co-workers have availed themselves for this comparative study is enviable. The increase in curative results from 12 per cent under the old chemotherapy, to 42 per cent by adding malaria therapy, and now to 58 to 65 per cent with chemo-fever therapy by physical means is most gratifying. The tables show that clinical improvement is accomplished even though the serologic reaction of the spinal fluid is not reversed. As time goes on, we are further realizing this to be a more constant observation. In this connection, may we hear the opinion of the authors regarding the relationship between a persistent serologic reaction and the status of the patient as to cure or safety from relapse. Quantitative blood studies, when practical, are valuable in these cases. I am also much interested in their opinion regarding the value of mapharsen as compared to tryparsamide in central nervous syphilis.

Drs. Bennett and Elkins have devised a very simple, yet practical, method for inducing hyperpyrexia in the animal without the need for anaesthesia. I hope they will extend, if possible, their comparative experiments to the cat and other animals which have channels of heat dissipation through the feet and organs other than the respiratory tract. If they have not already done so, I hope they will furnish us with information regarding comparative temperature readings of the subcutaneous lymph space, skin, muscles and viscera during the process of fever. We are badly in need of this information for clinical guidance. I am impressed with the potential clinical value of such determinations under a setup such as this, when the structures to be compared are completely divorced from the influence of the modality used for producing the fever. It must also be borne in mind that by this method we may gain much information on the existing relationship between the thermogenic brain center and peripheral structures.

I am inclined to disagree with one opinion expressed by the authors. They assume that during the experiment they are dealing with a peripheral vasoconstriction, and compare it to fever produced by typhoid vaccine. In crucial experiments upon the heat regulating center the following facts have been observed. When the center is exposed to heat there is peripheral vasodilatation with flushing. When cold is applied to the center, the opposite or peripheral vasconstriction with blanching and muscle rigor ensues. Under typhoid vaccine or foreign protein fever the center reacts to shock and the peripheral manifestations observed are those similar to the application of cold. In these experiments, it would be my opinion, that the thermogenic center is being exposed to heat.

Dr. N. E. Titus (New York): During the last war great use was found for whirlpool baths especially for peripheral nerve injuries. This means heat and one hundred per cent humidity, along the lines of Dr. Ferderber's research.

I am wondering if the author will not run a parallel series of observations with the whirlpool bath, for if it can produce results similar to those created by the apparatus designed at the University of Pittsburgh, more patients would take advantage of the knowledge.

The increasing lack of response of the bone marrow after repeated fever treatments was brought out by Bierman years ago. Linking this disability with chronic diseases leads to a possible explanation of the finding that fever therapy is ineffective in chronic arthritis. If a method of increasing bone marrow efficiency by diet or vitamin therapy can be worked out, possibly the combination with fever therapy will prove of value in chronic arthritis.

Too many neophytes in physical medicine reply on a single form of treatment, little appreciating that team work brings about the most success. Fever therapy started out as an individual form of treatment and then sulfanilamide entered the picture and revealed that it was eligible for the team. Bierman has long shown

that pelvic diathermy and fever are a good combination, and chemotherapy and fever have an established reputation in the management of syphilis.

Dr. Stecher's paper should serve as potent constructive criticism of fever therapy. No one can dispute the findings but one can only hope that some way can be found to utilize fever in the general scheme of arthritis therapy.

The author states that seventy-five per cent of the patients did receive temporary symptomatic relief. Such can also be obtained by other accepted physical agents. These can be more conveniently applied with equal effect upon the disease entity.

Dr. Ishmael's results are worthy of careful study for one might be led to the thought that fever has a good deal to do with activating specific immune reactions in the body. That it stimulates metabolism is conceded and what it does to promote general dissemination of chemicals was graphically shown to me when I watched over a patient who was given fever in an unsuccessful attempt to help her combat troubles due to bacterial allergy.

On one occasion she was given her autogenous vaccine about an hour before she was given fever. The subcutaneous injection in her arm below the deltoid raised the usual wheal about the size of half a golf ball. On other occasions this induration would last about four days. When given fever, however, the entire swelling disappeared when her temperature reached 103 F., showing the ability of the body to absorb this extraneous fluid had been greatly increased.

Dr. Kendell mentions the effects on air condition in a fever apparatus when the doors have to be opened frequently. That has been observed from the start. One cause for opening the doors is to give the patient a bed pan. When giving female treatments it has always been my procedure to irrigate the colon thoroughly with a special apparatus immediately before the treatment is started.

Since we know that absorption in general is increased, it is reasonable to expect that cleaning out the gut beforehand lessens the amount of intestinal toxins that may be absorbed during hyperpyrexia. Experience has shown that gastrointestinal disturbances during fever can be entirely eliminated if an efficient Dierker colon irrigation is given.

In the humiditherm that I use entrance to the chamber is through a zipper in the rubber curtain. This opening is of ample length to admit a bed pan for female patient. Inside the rubber curtain hangs a clean cotton curtain with a flap corresponding to the zipper opening. This acts to keep the hot humidified air in the chamber and when it is necessary to open the vent, the minimum amount of air is lost. Moreover zippers at the corners at the head end of the curtain make it possible to reach the patient's arm for blood pressure determinations with a minimum amount of air loss.

Dr. William H. Schmidt (Philadelphia): This series of papers on fever therapy illustrates the type of work that is helping physical therapy a great deal. It shows considerable diligence and scientific work, with a comparison of results that is of great advantage to all of us.

I was interested in Dr. Ferderber's paper. He has brought out quite clearly the point which I had held in the early days of fever therapy, which is, that the method of inducing fever does not make so much difference, as they all produce practically the same effect, and that it did not matter much whether it was internal heating or the heating was produced by external means. The suggestion he makes in his paper, of the possible development of immunity to fever, is quite interesting, and is a point that may explain some of our failures in the past in some of these patients. Another important thing is his work on local heating. That is something we should all bear in mind.

I want to second what Dr. Titus has said about the whirlpool bath, because I have found that this method has been effective in many of these conditions where other measures have failed. It may be that the explanation which Dr. Ferderber has worked out is the real truth of the matter.

The paper by Drs. Stecher and Solomon on arthritis also was interesting. We must realize, that atrophic arthritis is a generalized disease, with local manifestations. We have multiple joints involved, and local treatment of each joint is always difficult. We cannot expect to cure all these patients, because they have varied etiologic factors, but I do believe that fever therapy offers considerable help. It is not necessary in arthritis to use high fever; we can use temperatures around 101 or 102 F. This is easily borne and does not debilitate the patients, and as a rule they submit more readily.

I have found that we get relief a little quicker than one can in any other way in the treatment of these cases. It is particularly in those patients who have distinct foci of infection such as sinus infection, that show the best response.

Dr. Ishmael's paper is informative. The combination of autohemotherapy and fever is simply to augment the effect of the fever, and when the two are used together it is quite possible that we do get a prolongation of the effects.

It is well known that fever therapy will produce leukocytosis, and the same is true with autohemotherapy.

My experience in the treatment of gonococcic infection has been limited. I have treated some of the complications with fever therapy, and with good results. I had one particularly serious case of a nurse, who became infected from an infant with gonorrheal vaginitis, and she developed an extremely virulent type of infection. The patient was given a ten-hour treatment at a temperature of 106 F. with complete clearing up of the symptoms and negative culture after the one treatment.

I have always been interested in the desirability of running temperatures at 106.7 F. for prolonged periods. It has been shown from autopsies on patients who have died as a result of high temperature that there have always been hemorrhages in the brain, kidney, liver and other organs of the body. When a patient is sick with a temperature of 106.7 F. we feel that that patient is very seriously ill, and that certainly is also true with fever therapy. When one is running such a temperature one is in a danger zone, and it certainly is work that should not be attempted anywhere except under the very best of conditions with a trained personnel and where every emergency can be met.

I personally have not been inclined to run temperatures above 106 F.; I feel that it is safer not to do so and that the results are not much improved thereby. There has been some work done which shows that the leukocytes are mobilized by fever, but when the temperature is around 106, the activity of the leukocytes is decreased rather than increased. It seems to me, that ought to be a hint that the effect of very high temperature is not altogether the best. The idea of producing thermal death of the organism by artificial fever may be the right one — I am not prepared to say it is not but personally I feel we should be very careful about running these extremely high temperatures.

The combination of chemotherapy with artificial fever is very good. We should utilize every means we can to cure these patients, and if the combination of chemotherapy and fever is going to help in improving our results, we should give it, by all means. That, of course, holds true with syphilitic conditions as well as with the gonococcic infections.

The interesting presentation by Dr. Elkins opens up a field for experimental work, and enables the investigator to obtain fever in a simpler and probably easier way, and may lead to some very interesting results. I would be very happy to see the authors carry that work further and let us hear from them later on about the effects they will have obtained.

Dr. R. Piaskoski (Milwaukee, Wis.): I believe the one outstanding fact about this very fine symposium on fever therapy is that every paper stresses its use in combination with some other agent — sulfanilamide, autochemotherapy, bismuth and other anti-syphilis preparations — or as an adjunct to other treatment, as in arthritis. These reports show that fever enhances the action of these other agents and that we can obtain benefits with a combination of methods which we cannot get with any of these agents alone. We are able to decrease the severity of the treatment or the total number of hours of fever, and by so doing decrease the cost of fever therapy. It should lead to a more widespread use of this very powerful therapeutic agent. I was glad to hear once more, as was mentioned by several men, that personnel, nursing care and experience are most important in the successful administration of fever therapy, and that the apparatus used is of secondary importance.

In the treatment of atrophic arthritis by fever, we have gone through much the same course as outlined by Drs. Stecher and Solomon. Because of the severe and long-lasting weakness following longer and higher fever, we gradually reduced the duration and height of the fever until now we carry these patients at 104 F. for only an hour or two. We feel that the immediate relief of pain and stiffness and the increased motion is about the same as we saw with the more strenuous treatments.

We have treated about two hundred cases of this type in the last six years, and have had some very fine results and also some very poor results. Like Drs. Stecher and Solomon, I am convinced that fever therapy is not the answer to the treatment of atrophic arthritis; however, fever therapy administered in this mild manner is an important part of a regime which includes general medical care and persistent local physical therapy.

Dr. Ishmael's paper prompts me to speculate on the role of short wave therapy in the results reported. For several years we have been giving what we term prolonged short wave treatments. The usual short wave treatment is given for only ten to twenty minutes, but in resistant painful conditions we often cover the patient and apply the short wave current for an hour or two. The patient's temperature usually reaches 101 to 101.5 F. for about an hour. Our nurses refer to such treatments as "long" short wave treatments, rather than fever therapy. We have been favorably impressed with the benefits of this type of treatment.

I want to emphasize the importance of what Dr. Kendall referred to as individualization of treatment. At the Milwaukee County Hospital we are carrying out a long-term study of fever plus chemotherapy in neuro-syphilis. We give each patient a course of ten fever sessions, each consisting of three hours between 105 and 106 degrees. A bismuth preparation is given during each fever session. Then the patient is referred to the Luetic Clinic for additional chemotherapy. Later he may be given a second or third, or even a fourth course of fever therapy. Depending on his general condition, we may decrease the height of the temperature or shorten the duration of the treatment. In this way we are able safely to treat patients who are considered poor risks. We have obtained serologic reversals in blood and spinal fluid after thirty or forty fever sessions when there was no change following ten or twenty sessions.

Dr. Milton G. Schmitt (Chicago): In regard to the suggestion that more prolonged application of diathermy may be of advantage in certain cases I may comment that we have gone to the very great extreme of giving continual intermittent treatment in the fashion of applying twenty minutes of diathermy every hour, twenty-four hours a day, for as long as three weeks, without interruption. I am

quite convinced to date that this method is worth attention, and I believe that our results will bear this out when we publish them.

The paper of Drs. Solomon and Stecher clearly states that fever therapy does not cure atrophic arthritis but it does offer a great degree of relief from joint pain and stiffness. We are encouraged, therefore, to continue to use physically induced fever as a most valuable aid in selected cases. My experience is in agreement with that of the authors regarding the height of the fever curve. However, my work suggests that a sustained fever of five to six hours for ten successive treatments at weekly intervals increases the temporary permanency of the result. In those cases showing improvement, subsequent shorter courses of fever are of definite benefit in sustaining a continuance of improvement.

Dr. Ishmael's paper presents new observations which challenge further investigation. An optimal procedure must be worked out and applied without too much variation to a sufficiently large number of cases.

In following the observation of a postoperative fever, we note that it does not last for a single hour but rather for several hours or a whole day. This fact suggests that the benefits of the suggested therapy in this paper might be enhanced by increasing the length of induced fever.

The paper of Drs. Kendall, Rose and Simpson presents changes in technic over that of previous years. Those physical changes in the environment control of the patient in the cabinet are to be commended. However, some other practices set forth disturb me. The intravenous administration of 50 per cent glucose routinely several times during a single treatment, may not be necessary or desirable, and it may be somewhat hazardous. It is my opinion that this practice can be obviated by adequate preliminary preparation of the patient. It is my experience that a patient endures the treatment better after a substantial breakfast than when treated during a fasting condition. Also, that adequate amounts of glucose are well tolerated by ingestion if the patient is in need of such food.

The number of hours of fever given per treatment for syphilis and the procedure advised for gonorrhea seem to be in direct conflict. The reasons given for this practice are also in conflict. Let us examine the case. Three-hour fever sessions are given for syphilis. The reasons for this shortened procedure are economic, namely, (a) the nurse can give two treatments per day; (b) the patient can remain ambulatory; (c) the cost to the patient is reduced. Ten-hour fever sessions are advised for gonorrhea, together with nine days' hospitalization. The reasons given for using this scheme of treatment are scientific, according to the work of Carpenter, Boak, Mucci and Warren. I am wholly in accord with accepting this reference as authority. I ask at this point: Why use economic determinants for the procedure in one disease and scientific determinants for the technic of another disease? Are patients afflicted with gonorrhea better able to pay for a ten-hour treatment with the added expense of intravenous glucose, oxygen administration, and more days of hospitalization, than are syphilitic patients?

There is no comparison between results of former technics and those of the period described in the paper. Such a statistical comparison should be very valuable. We do well to remind ourselves that in fever therapy we are attempting to mimic a natural mechanism of defense in the body — namely, fever. A spontaneous fever does not occur once in a while for two or three hours, but rather endures all day, every day, until the pathologic condition is overcome. This fact is respected in the reported procedure for the treatment of gonorrhea, but seems to be somewhat disregarded in the reported treatment of syphilis.

The paper of Drs. Belt and Folkenberg is very informative in that it clearly sets forth facts which firmly establish the value of fever therapy of gonorrhea. I am exceedingly glad for the very special emphasis of adequate study and examination of the patient, and also the importance of several days of preliminary preparation. This has been my practice for the past six years, and I feel amply rewarded for so doing.

The paper of Drs. Bennett, Nielson, Fechner and Cash definitely helps to establish physically induced fever as a most important procedure for the successful management of active neurosyphilis, including paretic dementia. The paper of Drs. Elkins and Bennett indicates that the air which the fever patient breathes may be important in considering the ultimate optimal management of the fever patient.

Dr. William Bierman (New York): Dr. Ferderber appears to draw the conclusion that inasmuch as the leukocytic reaction which follows upon repeated exposures to heat diminishes, therefore the therapeutic value of this measure diminishes accordingly. I do not challenge that statement; it may be true. But I am impressed by the fact that there are numerous other changes that occur in addition to leukocytosis, so I was particularly interested in hearing him draw this parallelism between the diminished leukocytosis and the diminished therapeutic effectiveness of repeated treatments.

I would like to refer to one other paper, that of Drs. Elkins and Bennett. I would be very much interested to know if Dr. Bennett reversed the procedure — that is, if he put the rear portion of the dog in the hot box instead of the front portion. My reason for asking this is that we have had considerable experience with experimental animals, and we have observed that it takes very little heating energy to raise the temperature of fur-bearing animals — cats, dogs and rabbits. It is for that reason that I would be interested in having Dr. Bennett place the rear end of his dog into the heating cabinet rather than the front end. I do not for a mo-

ment deny that putting the front end in would be more effective, because the mechanism that the dog has for losing heat happens to be at the front end. He loses it through the respiratory mechanism. I would expect that the other mechanism at the rear would not be as effective, but it might be very effective — judging from our own experience — in elevating the temperature of the dog. If this is true, it is not necessary to refer to any special effects on the vasomotor centers in the brain. Undoubtedly they are influenced, but it may well be there is enough heating energy applied to a sufficiently large portion of the dog's body to be responsible for a very considerable elevation of the systemic temperature.

Dr. Murray B. Ferderber (closing): I should like to say that in the experimental use of determining the efficacy of the three types of heat, we had no intention first of taking deep temperatures. For some reason, that slipped by entirely. We were doing work in blood flow, relating to a definite industrial problem.

The procedure is as follows: Using the one leg of a dog, we inserted a Soskin flow-meter between the distal portion of one femoral vein and the proximal portion of another. The dog was under anesthesia, and we prevented clotting by using heparin. In this process we employed a Leeds-Northrup potentiometer, took the thermocouple readings and found that we did have deep temperature increase.

Now, in the use of infra-red we attempted to insert the thermocouple needle at that point which was not indirect contact with radiation from the generator, and actually found an increase in temperature varying from 103, I think, or close to 104, up to 105, and the temperature of the animal at that time, incidentally, was approximately 102 F. We did not insert the needle while we were giving short wave, but we inserted it immediately upon disconnecting the generator.

Certainly I would not dare to impose my own ideas on why we should or should not have a deep temperature, but is it not just possible that radiation effects alone would be sufficient — is that the point, Dr. Bierman?

Dr. Bierman: No. The question I raise is the effectiveness, particularly of conductive heat, in producing deep temperature.

Dr. Ferderber: If I recall rightly, some time ago Dr. Simpson in one of his papers considered the deep temperatures of various portions of the body. I do not know whether muscles were included or not.

Dr. Bierman: I am referring to the local heating.

Dr. Ferderber: The fact remains that we have had increased temperatures. Whether it was due entirely to conductive heat from the instruments used, I am not certain, but I am inclined to think that it is. Any further explanation, I would very frankly say I could not give. In the first place, my experience in this line is certainly limited, and perhaps time may give me some further explanation. I would be more inclined to accept what I think in the line of experimental evidence.

As regards the second point in reference to the blood count, it is true that not every patient with a low white blood count is going to succumb or fail to recover from an illness. However, the general summation of the cases treated, which numbered approximately three hundred and fifty, or between three and four hundred in this study, is that we were able to get a rather good indication that there is a definite relationship between the leukocytic response and recovery. We understand by "recovery" a fairly complete or a reasonably good return to normal function.

In answer to the remarks of Dr. Titus and Dr. Schmidt with reference to the whirlpool baths, in the use of this local unit I did not do the clinical work; it was conducted at the hospital, and my task is merely along medical-engineering lines. But the first seventeen or eighteen cases, according to our histories were treated with other modalities including the whirlpool bath, and it certainly would be important to see a comparison between the whirlpool bath and this local heating unit.

Dr. Phillips raised the question of dehydration. Because of the necessity for brevity, we did not cite our red counts, but they were not reduced; there was no dehydration. All our white counts are checked with red counts.

Dr. Schmitt, of Chicago, I am happy to see, gave a little support for the local treatment. I am glad to hear of his experiences.

I should like to thank Dr. Bierman and the discussants for being so kind to a very young industrial hygiene department of only two years, because we are actually trying to correlate this information in terms of its use in industrial hygiene, not necessarily from the clinical value but from some standpoint that might make recognition a little easier.

Dr. Walter M. Solomon (closing): Our paper may appear a bit pessimistic but that is not our intention. We are reporting our results in this form of arthritis in a large enough series of cases and after sufficient time to be helpful in establishing the value of fever therapy. We certainly had hoped that fever therapy would be more effective in securing objective improvement but as the figures show the final results are disappointing in this respect. However, subjective relief was secured in a sufficient number to warrant the continued use of this therapy.

Dr. Phillips raised the question as to the value of fever therapy instead of the relatively poor objective results. This viewpoint may be justified but one must realize that the majority of these patients had been given many types of treatment without securing either objective or subjective improvement so that at least with this therapy they were often freed dramatically and for varying periods of time of their symptoms.

Dr. William K. Ishmael (closing): In answer to Dr. Phillips' direct question as

to why the two measures should be given so close together, I will say that I give the two with the feeling that the fever reinforces the autohemotherapy, whatever its effect may be. However, his question is well taken, and I will try the procedure as he suggests.

Dr. Schmitt suggests that we increase the length of the induced fever, and I am of the opinion that he is entirely right.

Dr. Robert L. Bennett, Jr. (closing): In answer to Dr. Phillips, we have treated no animals other than dogs, nor have we determined any temperatures other than rectal. Obviously, much further experimentation must be done in this field.

Frankly, we have offered the suggestion that peripheral vasoconstriction might occur in the dog whose body temperature was elevated by the heat cabinet only in an attempt to explain in some way the maintained diastolic pressure.

In reply to Dr. Bierman, experiments with short wave diathermy over the body of the dog have been carried on. The results will be published soon. In this connection, however, I will say that we had difficulty in raising the temperature of the dog by this means, as the animal's heat dissipating mechanism is really amazingly efficient. By panting, the dog can keep his body temperature below 104 F., which can be considered the upper limit of the normal temperature in summer.

SHORT WAVE DIATHERMY OF THE CAROTID SINUS *

A. B. HERTZMAN, Ph.D.,
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and
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The importance of the carotid sinus for the reflex regulation of the circulation and respiration demonstrated by the classical experiments of Hering, Koch, Heymans,[1] and others, has led to a search for suitable clinical tests of the sensitivity of the sensory endings in this structure. Results with digital compression of the carotid sinus and of the common carotid artery have been reported by Weiss and associates,[2-3] Gammon[4] and others. It is possible, however, that such an artificial mechanical excitation of the carotid sinus need not quantitatively duplicate the natural stimulation by changes in endosinal pressure. Recently Vannotti[5] observed the apparently specific stimulation of the depressor endings in the carotid sinus by short wave diathermy (6 meter) wavelengths over this structure, eliciting a prompt depressor reaction which disappeared immediately on stopping the application. These results are surprising in view of the tendency to consider that heat alone is responsible for the effects of short wave diathermy.[6-7] Although a specific sensitivity of the carotid sinus to short wave diathermy is improbable, thermal sensitivity of the carotid nerve endings has been well recognized, since the experiments of Zbyszewski[8] and Tournade, Malmejac and Jourdan[9] demonstrated a rise in blood pressure with local cooling and a fall in blood pressure with local heating of the carotid sinus.

The possibility of testing the sensitivity of the carotid sinus endings in a quantitatively reproducible manner, convenient and comfortable to the patient, induced us to repeat Vannotti's experiments, in the hope that short wave diathermy of the carotid sinus would produce a sufficiently localized thermal effect to elicit evidence of stimulation.

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Experiments

Electrodes were placed over the unexposed carotid sinus in dogs, cats, and rabbits anesthetized with morphine-urethane. Electrodes varied in size but were most often 6 by 6 cm., the same size used by Vannotti. Respiration was recorded with a pneumograph and the arterial blood pressure from the femoral artery with a mercury manometer. Short wave applications varied in wavelength (6, 12, 16, and 18 meters) but were most often 6 meters, the same wavelength used by Vannotti. Duration of the application varied. The applications were made over the region of the unexposed carotid sinus, the two electrodes being at opposite sides of the neck. They yielded responses typically illustrated in figure 1 and characteristic of ther-

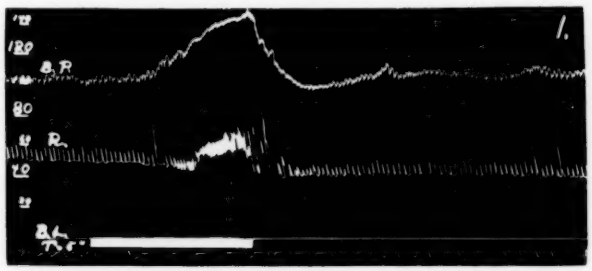

Fig. 1. — Dog. Diathermy 6-m. Electrodes 6 cm. x 6 cm. over carotid sinuses. B.P. = blood pressure; R = respiration (pneumograph). Diathermy application indicated by heavy line. T = time in 5 seconds.

mal stimulation of the medullary centers: hypertension, tachycardia, polypnea. The circulatory changes as indicated in the heart rate and blood pressure were frequently minimal, while the thermal polypnea was very pronounced. Occasionally, the thermal polypnea of dogs during hot weather was temporarily reduced by the diathermy. Apparently direct thermal influence on the brain-stem was consistently dominant in the response, so that distinction of stimulation of the carotid nerve endings was not possible. The short wave application tended to arouse the animal, providing the anesthesia was not too deep, giving evidence of painful stimulation. Decrease of the energy output diminished the signs of stimulation without demonstrable effect on the carotid sinus. Shifting the electrodes craniad or caudad did not result in evidence of stimulation. Thermal effects on the brain diminished as the electrodes were moved caudad (figure 2 — electrodes low in neck)

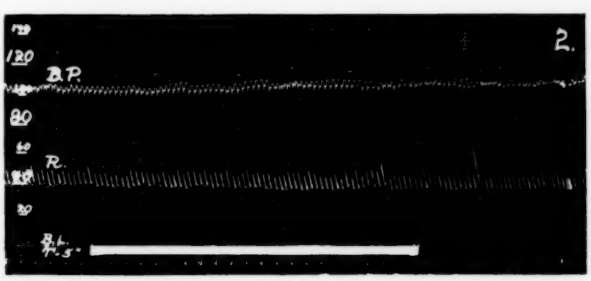

Fig. 2. — Same preparation: Diathermy with electrodes low in neck.

and decreased the intensity of the electrical field to which the brain was exposed. Attempts were made to stimulate the aortic depressor nerve by short wave but were wholly unsuccessful. The brain was not in the field in the latter experiments.

Increase of the depth of anesthesia tended to abolish the stimulating effects of transverse diathermy of the carotid sinuses and brain-stem. Figures 3 and 4 show disappearance of the hypertension and polypnea in response to the diathermy after a second dose of urethane administered in the interval between the two records. This effect of the anesthetic may be related to the apparent exception to the usual results shown in figures 5

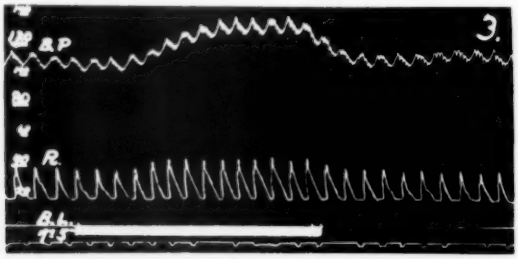

Fig. 3. — Dog. Diathermy 6-m. electrodes over carotid sinus.

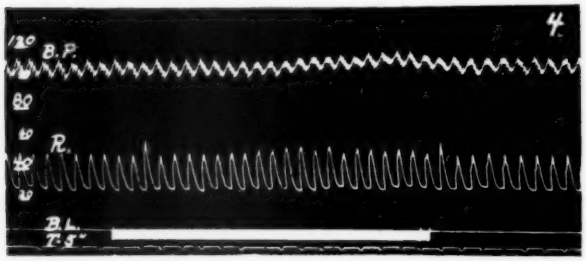

Fig. 4. — Same preparation: Diathermy 6-m., 30 minutes after additional urethane. Interval indicated by break in record.

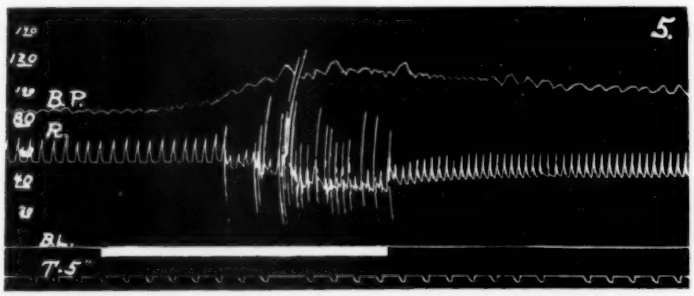

Fig. 5. — Rabbit. Diathermy 6-m. electrodes over carotid sinus.

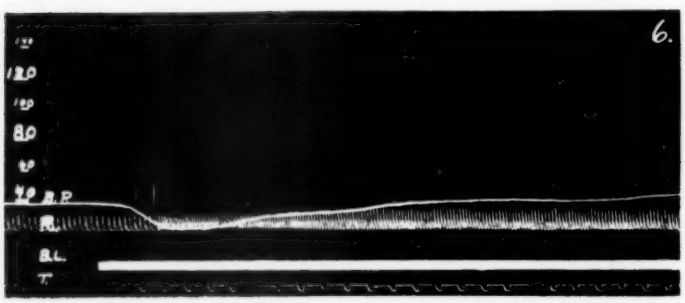

Fig. 6. — Same preparation: Diathermy 6-m., 40 minutes after additional urethane.

and 6. In this experiment, the rabbit gave the usual response to the diathermy (figure 5); it was then deeply anesthetized until the blood pressure had fallen to a low level (36 mm. Hg.). Repetition of the diathermy over the carotid sinus gave a depressor response which tended to disappear as the diathermy continued. The depressor response reappeared later (not shown). The usual thermal polypnea obtained. In severely depressed animals with a decreased cerebral blood supply, diathermy ran the risk of thermal coagulation. Interpretation of the depressor reaction shown in figure 6 therefore does not necessarily point to selective stimulation of the carotid sinus in this experiment.

The failure of these animal experiments to demonstrate a selective stimulation of the carotid sinus by short wave diathermy compelled us to investigate our technics for an explanation. Various combinations of electrodes of various sizes separated by various thicknesses of separators were tried with different wavelengths and current intensities as supplied by several apparatus. In no instance did we obtain evidence of carotid sinus stimulation. Finally, we exposed the structure and attempted to localize the current on it, but this procedure merely resulted in thermal coagulation. This experiment was unimportant since it was not relevant to the clinical problem of selectively stimulating the carotid sinus receptors with short wave diathermy.

Repetition of these experiments on normal men yielded results essentially similar to those obtained on animals. Blood pressure either remained unchanged or rose — no evidence of depressor stimulation was obtained.

Transverse diathermy over the carotid sinuses of patients with hypertension resulted in an erratic behavior of the arterial blood pressure. The psychic stimulation from the determination of the blood pressure and especially from the procedure itself made it very difficult to interpret the relatively small effects obtained. Small pressor effects may appear early during the diathermy and disappear as the patient remains comfortable. There also was vertigo in one case. Moderate depressor responses were elicited in a few instances, which persisted for some time after the diathermy. It seemed doubtful that these were due to selective stimulation of the carotid depressor nerve, for reasons to be given below. In one case, a high unstable systolic pressure stabilized at a lower level during the diathermy period rose and fluctuated again after the diathermy.

Discussion

The results of these experiments are inconclusive with respect to the possibility of selectively stimulating the carotid depressor nerve by diathermy. It would appear that in our experiments the spread of the current was sufficient to involve the medullary centers simultaneously with the carotid sinus. Although various diathermy units, different wavelengths, various electrodes and varied spacing were tried, we were unable to obtain evidence of selective action on the carotid nerve endings. Vannotti's positive results may be related to a more accurate control of current penetration and spread. The theoretic possibility must be granted that localized heating of the carotid sinus by diathermy with exclusion of the medulla from the thermal effects would provide a means for the selective stimulation of the depressor mechanism. It may be that in our experiments the diathermy units available to us did not provide the necessary localization of thermal effect.

The depressor response obtained on several hypertensive patients remind one of the reports of Raab[10] who found significant decreases in arterial blood pressure in these individuals by diathermy of the brain-stem. He

considered this depressor effect (which was not obtained in normal individuals) as due to a decrease in the otherwise exaggerated tone of the vasomotor center in response to improvement of its blood supply. We see no reason for a different explanation of our similar results, particularly in view of the fact that Frey and Schneider[11] have demonstrated dilatation of the cerebral vessels and increased cerebral blood flow as a result of diathermy of the head.

This may also account for the alleviation of symptoms (such as headache) and the fall in blood pressure obtained by Vannotti with short wave diathermy of the carotid sinus region in hypertensive patients. It is interesting to note that the therapeutic benefits continued after the treatment appeared to be cumulative. This is difficult to reconcile with their origin in carotid sinus stimulation which would cease with removal of the stimulus, the diathermy current. The results are intelligible, however, in terms of increased cerebral blood flow, shown by Frey and Schneider to be maintained for some time after the conclusion of the session.

How much of a role the thyroid would play in delayed effects from diathermy is a question of considerable interest. We have seen in one patient an exacerbation of thyroid symptoms induced by this agent. Vannotti reports similar instances. Since the relation of the thyroid secretion to blood pressure levels is by no means clear, hyperactivity of the gland induced by diathermy must be considered in the interpretation of the delayed effects on hypertensive patients. Stimulation of glandular activity by diathermy has been reported by several observers.[12]

Summary

Attempts to elicit carotid sinus depressor reflexes by application of short wave diathermy to the region of the carotid sinus in dogs, cats, rabbits, normal men and hypertensive patients were usually unsuccessful. Hypertension, tachycardia and polypnea usually resulted, indicative of thermal effects on the brain-stem. Depressor effects were obtained in rare instances.

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(Concluded on page 361)

A METHOD OF COMPARATIVE CLIMATOLOGIC INVESTIGATIONS

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Investigations concerning the influence of climate on living organisms are very numerous, but often the results are ambiguous as well as contradictory. This is understandable if one considers that neither the agent — the climate, nor the receptor — the living organism, represent single factors or a simple structure. Therefore, to carry out studies in this theoretically as well as practically important field, different approaches must be tried. One of these is a method of comparison, which means that on one side the climate in its totality, or excluding one or several of its factors, and on the other side a single or several of these factors under constant laboratory conditions may influence living organisms of the same kind. By comparing analyses of the results obtained under these various conditions, it is possible to establish the effect and the importance of the various factors of climate and to use them for the practical purposes of climatotherapy.

On a scientific expedition in the Caucasus Mountains* to continue previous work upon the influence of diminished air pressure on metabolism, the writer began such investigations on white mice which were continued later in Leningrad under controlled laboratory conditions.

Plan of Studies

The arrangement of the investigations is schematically shown in table 1. According to this, the whole climate is divided into physical factors, one or several of which could influence the experimental animals at the same time. The acting factors are shown in the table by asterisks.

TABLE 1.

			Climatological Factors									
			Radiation			Temperature		Air Pressure				
		Duration of the Experiment in Days	Ultraviolet	Visible	Infra Red	High	Low	700 mm. Hg.	570 mm. Hg.	440 mm. Hg.	Other Factors
Expedition Experiments	Nalchik, Light-Group	7	*	*	*	*	....	*	....	....	*
	Nalchik, Dark-Group	7	....	....	....	*	....	*	....	....	*
	Terskoll, Light-Group	8	*	*	*	*	*	....	*	....	*
	Terskoll, Light-Group	35	*	*	*	*	*	....	*	....	*
	Terskoll, Dark-Group	8	....	....	....	*	*	....	*	....	*
	Terskoll, Dark-Group	35	....	....	....	*	*	....	*	....	*
	Priyut, Light-Group	10	*	*	*	....	*	....	....	*	*
	Priyut, Dark-Group	10	....	....	....	....	*	....	....	*	*
Laboratory Experiments	High temperature	14	....	....	....	*	....	....	....	....	....
	Low temperature	12	....	....	....	....	*	....	....	....	....
	Visible Light	9	....	*	....	....	....	....	....	....	....
	Air Pressure	6	....	....	....	....	....	*	....	....	....
	Air Pressure	6	....	....	....	....	....	....	*	....	....
	Air Pressure	20	....	....	....	....	....	....	*	....	....

* The results represented in this paper were published in part in the report of this expedition ("Elbrus Expedition 1934 and 1935." Academy of Sciences Press. Moscow and Leningrad, 1936).

In spite of some doubt, white mice were selected as the experimental animals because their surface which is free from hairs(ears, tail) is comparatively large. This was of distinct importance for all irradiation experiments as irritation of the skin by removing the hairs in shaving or in any other way was avoided. The animals all were of the same breed and were nourished in all experiments in the same way, with milk, bread and oats.

The investigations during the expedition were made in July and August, 1935, at three points in the northern part of the Caucasus Mountains, namely, at:

1. Nalchik, 500 m. (1600 ft.) above sea level,
   average air pressure 715 mm. Hg.,
   average air temperature 28 C.,
   June 30 — July 9.

2. Terskoll, 2200 m. (7200 ft.) above sea level,
   average air pressure 580 mm. Hg.,
   average air temperature 14 C.,
   July 10 — August 16.

3. Priyut Deviati, 4250 m. (14,000 ft.) above sea level,
   average air pressure 440 mm. Hg.,
   average air temperature 0 C.,
   July 22 — August 7.

At these three points, the animals of the "light-group" were exposed for about 6 hours every day, whenever it was possible, to the complete radiation of the sun and the sky, while the "dark-group" were kept in closed boxes in faintly lighted rooms for the entire time. At the altitude of 2200 m. (Terskoll), besides the division into a light and dark group there was a division of duration at this point (3-9 respectively 33-36 days) to determine any appearance of acclimatization. All animals were brought by a four-day trip from Leningrad to Nalchik. Before reaching Terskoll, they all had been 11 days in Nalchik, and the group which was taken to Priyut Deviati had previously lived 12 days at Terskoll.

An irradiation of several hours each day is an extreme condition, but it was used to obtain as marked results as possible. Generally, it can be said that the animals withstood all the climatologic changes astonishingly well. The mortality was not greater than usual. In appearance, the irradiated animals in most cases were distinguished from the dark ones. While the latter at all times appeared normal, the light animals sometimes had a rough coat or inflammation of the eyes.

The evening before being investigated, the animals were separated from the others and did not receive any food, except water. For each animal the weight of the organs — liver, spleen, kidneys, heart and lungs — was determined, as was the sugar and non-protein nitrogen of the blood, the amount of fats and lipoids of the liver and, in some cases, of the other mentioned organs.

The results of all these investigations are shown in table 2, which contains also all necessary data concerning the number of investigated animals, the duration of the treatment, and other factors. In order to demonstrate the changes as clearly as possible, the accompanying charts show the relative weight of the organs. In these, each group of animals is represented by a column the height of which is determined by the average weight in per cent of the normal, the latter in every case being equal to 100. The columns of the experiments which were carried out in the laboratory are divided into two parts showing the relative weight in relation to the initial and to the final body weight. This enables us to judge whether the weight of an organ has been changed absolutely or only in accord with a change in body weight.

TABLE 2

	Laboratory Experiments							Expedition Experiments							
Duration of the Experiment in days	.....	11–16	12	7–9	6	5–7	20	6-8		5-10		33-36		6-14	
Experimental Conditions	Normal	High Temp. 30° C.	Low Temp. 5° C.	Visible Light[1]	Diminished Air Pressure 700 mm. Hg.	540 mm. Hg.	540 mm. Hg.	500 m. Non-Irradiated	Irradiated	2200 m. Non-Irradiated	Irradiated	2200 m. Non-Irradiated	Irradiated	4250 m. Non-Irradiated	Irradiated
Number of Investigated Animals	12	9	13	9	6	8	6	7	7	12	12	7	5	8	11
Weight of the Animal in g.															
Before	.....	24.9	22.4	19.5	21.1	24.1	20.4	.....	.....	.....	.....	.....	.....	.....	.....
After	22.9	22.9	20.4	19.4	19.1	21.2	18.7	18.3	17.2	17.7	16.2	22.4	19.4	17.7	19.4
Weight of the liver in g	1.10	1.14	1.18	1.07	1.03	1.30	1.07	1.08	0.98	0.97	1.02	1.30	1.21	1.02	1.10
Weight of the spleen in g	0.219	0.225	0.242	0.215	0.212	0.358	0.322	0.318	0.324	0.245	0.321	0.314	0.236	0.330	0.268
Weight of the kidneys in g	0.358	0.296	0.346	0.280	0.298	0.298	0.312	0.254	0.258	0.254	0.232	0.364	0.318	0.264	0.304
Weight of the heart in g	0.139	0.129	0.130	0.123	0.118	0.124	0.141	0.120	0.115	0.117	0.109	0.138	0.131	0.122	0.148
Weight of the lungs in g	0.241	0.262	0.258	0.272	0.249	0.301	0.363	0.214	0.215	0.244	0.248	0.287	0.256	0.252	0.288
Bloodsugar mg. %	102	98	107	124	92	89	105	172	188	119	138	98	161	113	100
Non-protein-N in blood mg. %	60	....	103	78	65	78	133	(35)*	(53)*	(40)*	(49)*	(65)*	(56)*	(44)*	(61)*
Ether-soluble substances in % of:															
Liver	12.9	14.0	13.0	.....	.....	14.5	13.6	13.1	13.6	19.3	23.2	11.5	10.7	12.4	10.1
Spleen	.....	.....	.....	.....	.....	.....	.....	7.1	8.1	8.5	7.2	.....	.....	8.2	7.4
Kidneys	.....	.....	.....	.....	.....	.....	.....	12.9	13.6	13.7	17.5	.....	.....	17.0	16.0
Heart	.....	.....	.....	.....	.....	.....	.....	8.0	8.2	12.3	9.6	.....	.....	8.5	10.2
Lung	.....	.....	.....	.....	.....	.....	.....	13.0	11.5	13.2	10.2	.....	.....	11.0	10.7

[1] These experiments were made with an electric lamp of 300 watt at a distance of 60 cm. The ultraviolet and infra-red radiations were absorbed by a glass and water-filter.

* See Page 359.

Weight of the Organs

Liver. — The weight of the liver is increased by cold, by visible light, and by greatly diminished air pressure. If the air thinning is prolonged to 20 days, the weight of the liver approaches the norm, but does not reach it. Obviously, this is to be considered as acclimatization, if by acclimatization is understood a return to the normal value. Slight rarefication (700 mm. Hg.) does not change the absolute weight, but it causes a relative increase as a result of the decrease in the body weight. Heat produces no change.

During the expedition, under the "complex" effect of the whole climate, there occurred in all groups an increase in the weight of the liver. As shown in chart 1, *A*, this increase was noted already in Nalchik (500 m.). At this place two factors are to be considered; namely, a slight rarefication and a high temperature. Since the corresponding laboratory investigations show that high temperature has practically no effect, it appears that the observed results are actually due to the diminished air pressure. However, for two reasons it is not sufficient to regard the diminished air pressure as the only active factor. First, the increase of the weight is much greater than under the corresponding laboratory experiments, and, second, there is no effect of the light which was expected according to the irradiation experiments. Therefore, the results may be explained as follows.

The comprehensive changes of the whole climate to which the animals were subjected by the transition from Leningrad to Nalchik, including the four days journey in the train, had a "shock-like" effect on the entire metabolism which resulted in a considerable increase of the relative weight of the liver. As a consequence of this complex* the specific importance of the various factors may be different than under laboratory conditions. In the further course of the expedition, there was no more such radical changes of the climate and therefore it is possible to explain the following variations by the effect of certain single factors. The dark animals in Terskoll (2200 m.) show approximately the same increase in the weight of the liver as those in the laboratory. Likewise it is established that the liver is enlarged by ordinary light. The same occurred in the group which remained for a longer period at this altitude, the only difference when compared with the laboratory animals, being that there was no acclimatization in the sense of an approach to normal values.

At the altitude of 4250 m. (Priyut Deviati) besides the diminished air pressure, one must consider also the low temperature as an effective factor. Unfortunately there were no laboratory observations on the effect of this air pressure (440 mm. Hg.) for comparison. However, Loewy and Cronheim[2] have shown that at an air pressure of 300 mm. Hg. the relative weight of the liver decreases. This loss at higher altitudes is balanced in the present investigations by the influence of low temperature causing an increase so that in the results, the weight of the liver remained unchanged.

In regard to the influence and the importance of the radiation of the sun at these altitudes, it is not possible to draw any conclusions on the basis of the present results. The fact that at this point the usual increase does not occur, can be explained by various factors which shall be considered later.

Spleen. — Chart 1, *B*, shows the relative weights of the spleen which are of especial interest due to the importance of this organ in the circulation and the formation of the blood. An influence is effected in the first line by diminished air pressure. This is in accordance with earlier observations on mice and other

* Various observations point out that in this complex effect the diminished air pressure is of greatest importance. In this connection we refer to the results of Zuntz and coworkers[1] who by their very accurate experiments at Monte Rosa (Switzerland) established that a stay at an altitude of even 500 m. influences the human protein metabolism (protein-retention).

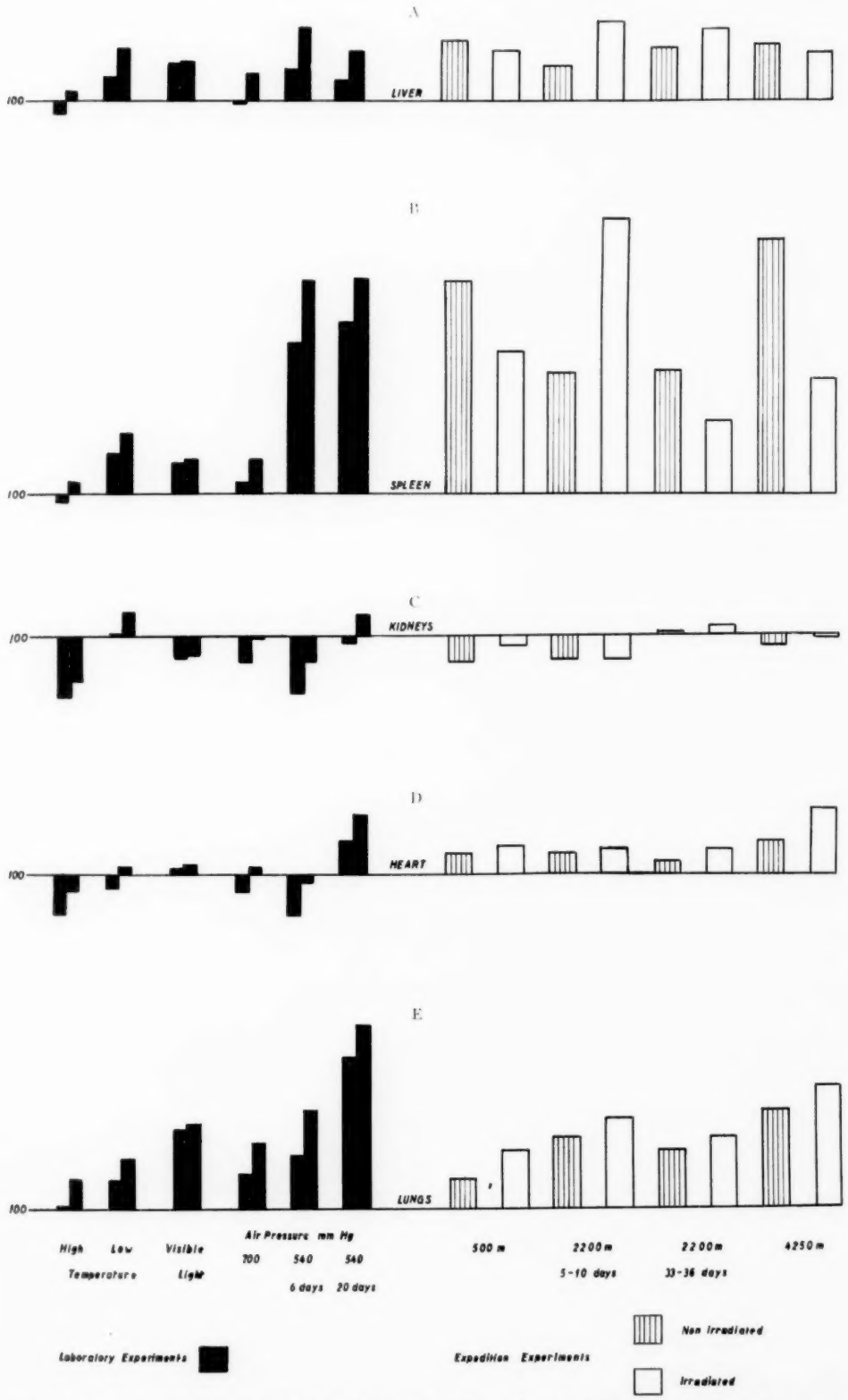

Chart 1, *A-E*. — The relative weights of the organs under various conditions in relation to the norm.

animals where sometimes enormous weights have been found by Loewy and Cronheim.[3] A small increase is also produced by visible light and by low temperature, while high temperature exerts no effect.

The results obtained in the expedition are not explainable. They show no relation to the altitude, and the effect of the irradiation in three of the four groups is opposite to the laboratory results. Therefore, it must be supposed that other factors than those investigated are of importance, or the combination of all factors, i.e., the whole climate may have an entirely different effect than one would expect according to the laboratory experiments.

Kidneys.—The results obtained for the kidneys are quite definite (chart 1, *C*). Under laboratory conditions, higher temperature, light and diminished air pressure increase the weight of these organs while low temperature decreases it. This may be explained by the water metabolism. In all cases where the loss of water is great, the kidneys become lighter, while they increase their weight retaining the water in a low temperature. On this basis the results of the expedition can be understood. At the first station (Nalchik) with its high temperature (30 C.), only the effect of heat is observed and that in a higher degree for the dark-group because the ventilation there was not as good as for the light-group. Passing on to the second station, with an average temperature of 14 C., the effect of the heat is replaced by that of the diminished air pressure, thus maintaining the decrease in weight. After a longer stay at this altitude, just as under laboratory conditions, it approaches the norm as a result of acclimatization.

At the third station (Priyut Deviati, 4250 m.) where the average temperature was only 0 C., the effect of the rarefied air is compensated by that of the cold, and the weight of the kidneys reaches the normal value.

Heart. — Instructive are the results obtained for the heart (chart 1, *D*). It can be seen that low temperature and slightly rarefied air exert no effect, while high temperature reduces and increased rarefying enlarges the heart, and that in greater degree the longer it continues. Adjustment to the diminished air pressure occurs, if at all, very slowly. This is of distinct importance because it shows what effect the altitude of 4250 m. with an air pressure of 440 mm. Hg. can cause in white mice.

In general, the expedition results are easily understood. At the altitude of 2200 m. an enlargement caused by diminished air pressure was found and, as mentioned above, this effect was still unchanged after four weeks. At the altitude of 4250 m. the enlargement is even more marked.

The increase of the heart weight at the first station (Nalchik) cannot be explained. Following the laboratory results one would have expected a decrease caused by the high temperature. Why the opposite occurred could not be determined by the investigations.

The effect of light is uniformly an enlargement. Although the observed increase in some cases is small, nevertheless it is to be regarded as a real one because it occurs without exception in all groups. Possibly the spectral composition of the light is of some importance since the ultraviolet radiation probably has more effect than visible light.

Lungs. — Entirely uniform are the results obtained for the lungs (chart 1, *E*). Excepting high temperature, which causes only a relative increase, all other investigated factors effect an absolute enlargement of the lungs. According to these results in the expedition, an increase was found in all groups which shows only quantitative differences in proportion to the altitude. In the light groups this increase is still greater than in the dark group, thus showing the effect of the radiation. This means that the radiation adds its influence to that of the other factors, especially that of diminished air pressure.

Chemical Investigations

Non-protein Nitrogen in the Blood. — The content of non-protein nitrogen in the blood is shown in table 2. It must be noted that in the laboratory the determinations were made by the usual Micro-Kjeldahl method with distillation, while during the expedition, for technical reasons, it was necessary to use the method of Rappaport.[4] This method avoids distillation, but it seems to give too low values for the non-protein nitrogen. Therefore the results of the expedition may not be compared directly with those of the laboratory experiments.

Under laboratory conditions the non-protein nitrogen is really increased by low temperature and continued air thinning. Visible light and diminished air pressure of short duration seems to cause a slight increase. During the expedition where, for the above reasons the absolute values are too small, the changes occur in the same direction. The non-protein nitrogen is increased in proportion to both the diminution of the air pressure and the time of its duration. Furthermore, in most cases the non-protein nitrogen is increased by irradiation. The effect of the duration of the air thinning on the non-protein nitrogen of the blood is important, and, probably, some opposite results of various authors can be explained by considering this time factor.*

It may be pointed out that the increase of the non-protein nitrogen in the blood certainly is related to the protein autolysis which was found by Laubender[5] and by Loewy and Cronheim[2] in the liver of guinea pigs and rats by diminished air pressure.

Blood Sugar. — For the sake of completeness, table 2 presents the values of the blood sugar. A great increase was noted in both groups in Nalchik. Since this cannot be explained by the effect of single climatologic factors, it is possibly due to the above mentioned "shock" effect by the transportation from Leningrad to Nalchik. A further discussion concerning the blood sugar will be given in a subsequent paper.

Fat and Lipoid Content of the Organs. — In papers by Loewy and Cronheim already referred to, it has been shown that the air thinning may produce a considerable increase of the fat and lipoid content of the liver in all animals studied (guinea pigs, rabbits, rats and hens). In mice, Elias and Taubenhaus[6] found no increase, but a decrease of the fat and lipoids. It seemed remarkable that these animals should behave just the opposite to other animals. However, it was not possible to give an explanation.

The animals in Terskoll (220 m.) showed in many cases the typical appearance of fatty degeneration of the liver (yellow color and granular pattern). These changes disappeared after a few days and were not seen later, even in higher altitudes. Therefore, quantitative determinations of the fact and lipoid content were made. For this purpose, the livers, dried at 35-40 C., were extracted with ether and the amount of the extract was weighed.* The results are shown in table 2.

The above mentioned observations were confirmed by the chemical investigations. Thus it can be established that in white mice, too, the diminished air pressure can produce a fatty degeneration of the liver. It has to be pointed out that this degeneration occurs at a comparatively low altitude (2200 m. or 470 mm. Hg.), after a short time and for a limited period. A longer stay at this altitude or a transition to higher altitudes does not increase the ether-soluble substances. On the contrary, their quantity decreases to normal and below.

* For details see: A. Loewy, Physiologie des Hochgebirgsklimas. Berlin, 1932.

* As control, the loss of weight of the dried liver was also determined. The differences in both methods never exceeded 3 per cent.

These latter results confirm the above-mentioned observations of Elias and Taubenhaus.

Table 2 shows only the average values of each group. Generally it is permissible to take the average because the individual fluctuations are not great. The only exception is in animals which were investigated after the short stay at the altitude of 2200 m (Terskoll). There the time factor is of greatest importance as can be seen from table 3, which contains the individual values of all

TABLE 3. — *Content of Ether-soluble Substances in Dried Liver in Per Cent at an Altitude of 2200 m.*

After	3 days	4 days	7 days	8 days	9 days
"Dark"-group	15.5	32.9	14.3	11.1	24.9
	.....	24.4	11.9	.....	25.2
	.....	.....	22.9	.....	14.1
	.....	.....	14.7	.....	.....
Average	15.5	28.7	16.0	11.1	21.4
"Light"-group	12.5	29.7	21.8	34.6	22.2
	.....	29.1	21.4	.....	14.2
	.....	.....	34.1	.....	16.3
	.....	.....	30.6	.....	11.4
Average	12.5	29.4	27.0	34.6	16.0

animals of this group. Although the figures are not numerous, it appears that the maximal fatty degeneration occurs between the fourth and eighth day.

Under laboratory conditions also there is a certain dependence of the fatty degeneration on the duration of the air-thinning, but these differences are smaller than under natural conditions. Unfortunately, there were no special experiments on the influence of the greater air-thinning and of the light, i. e., of those factors, which in connection with time are of greatest importance.

From table 2, it can also be seen that heat increases the ether-soluble substances of the liver. Similar observations in guinea pigs were made by Gubser[7] and by Loewy and Cronheim,[2] but in this case, the increase is due mainly to the neutral fats and not to lipoids as by diminished air pressure.

Following up these discussed changes, it was intended to make investigations concerning the fat and lipoid metabolism of the other organs. Loewy and Cronheim[8] had already mentioned that the heart of guinea pigs in diminished air pressure has a yellow-red appearance instead of the normal dark red. Since it was not possible to complete the study of other organs, the amount of ether-soluble substances was determined only in the most interesting cases, i. e., in the expedition animals.

Table 2 shows that considerable changes occur in some organs and by investigating these changes more in detail, certain important results will be obtained concerning the fat and lipoid metabolism and its relation to climatologic factors.

Summary

On a scientific expedition in the Caucasus Mountains and under controlled laboratory conditions, investigations were carried out concerning the influence of the whole climate and of single climatologic factors on metabolism.

The experiments were made with white mice and the following determinations made: the weight of the organs, the content of sugar and non-protein nitrogen in the blood, and the content of fat and lipoids in the organs.

The proposed method of comparison used has been approved. In some

cases (kidney, heart, lungs) it is possible to explain the observed influence of the whole climate by the effect of one or several climatologic factors. In other cases (spleen) such deduction was not possible, thus indicating that either still other factors than those considered are of importance, or that the cooperation of several factors may produce another effect than would be expected by summing up the single factors.

If a deduction is possible, it does not mean that an explanation is given why and how the climate acts in the observed manner. This can be done only by a detailed investigation concerning one climatologic factor or one physiologic or biochemical effect.

The observations presented demonstrate the value of the method of comparison in climatologic studies.

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POINT HEATING AND MECHANICAL EFFECTS OF SHORT WAVES *

WILLIAM KRASNY-ERGEN, M.D.
STOCKHOLM

The literature on the influence of short waves on organisms contains much that deals with thermic effects, in addition to which two groups of reactions have been discussed: (1) Reactions without simultaneous measurable heating, and (2) those which appear with simultaneous measurable heating, but take a course different from one if the reaction were caused solely by increase in temperature.

Attempts have been made to explain these two groups of the effects of short waves which cannot be attributed to macroscopic heating by so-called "point-heating," a term given to a hypothetical phenomenon of small particles (microorganisms, and the like) attaining a temperature higher than that of their surrounding structures. This heat is supposed to be caused by the difference between the conductance and the dielectric constant of these particles and those of their environment. It was asserted that owing to this difference more heat is induced in the particles than in an adjacent volume of equal size, provided the wavelength of the field has a suitable value.

Attempts have been made to explain the first of the above given groups of reactions by a hypothesis of "point heating" as being effected by heat that is not measurable because it is confined to a very small volume.

The second group of effects according to the same hypothesis of "point heating" is attributable to the circumstance that the difference of the temperature in a small particle and of that in its environment — a difference possible only with short waves — has certain peculiarities which differ from any effect produced by macroscopic heating.

Since the hypothesis of "point heating" rests on temperature increases that are not measurable, it seems impossible to challenge it by experimentation. However, Liebesny[1] and Kulka[2] endeavored to solve this problem by utilizing indicators of the temperature in yeast cells. These indicators varied in color according to the temperature changes in these cells with an accuracy within one degree centigrade. This method of investigation disproved the assertion that the cells in the field were heated above the average temperature of the nutrient medium, for it was established that the temperature in the interior of the cell was by no means higher than 1 C. of that of the medium. On the other hand, the method does not enable us to state that the temperature difference was lower.

The following objections have been raised. If this difference in temperature between two very near points, that is, one point in the yeast cell and the other in the immediate proximity, actually amounts to one degree (C.), the gradient of temperature in the yeast cell would attain the order of magnitude of 1,000 degrees/cm. Any biologic effectiveness of such a high gradient of temperature cannot be ignored with safety. As a result, the hypothesis of point heating was not established experimentally, but also could not be disproved. Nevertheless, this hypothesis could be tested by theoretic calculations. For this purpose I[3] compared the heat produced by the field in a small particle with that which it loses to its environment by heat conduction.

* From the Wenner-Grens Institute for Experimental Biology, University of Stockholm, Sweden.

This thermal quantity, of course, increases in proportion to the increase of the temperature difference between the particle and its surroundings. Thus if this difference is subjected to a gradual rise, the quantity of heat lost by the particle soon reaches that of the heat produced in the field, when the temperature difference no longer rises. For this equilibrium an upper limit was sought for the temperature difference between the particle and its surroundings. Heat convection and radiation were not considered because they can only decrease the temperature difference, so that in a practical way the upper limit is not reached.

It could be demonstrated that the above mentioned upper limit is proportional to the field's effect/cm^3 and inversely proportional to the thermal conductivity of the particles and of the material in which it is suspended. In strong fields and with low thermal conductivity the temperature difference between the particle and its surroundings is consequently larger than in weak fields or with great thermal conductivity. In addition to this obvious result it was, however, found, that the upper limit is also proportional to the square of the diameter of the particle.

Assuming an energy of the field of 1 W/cm^3 (which is exceedingly high for therapeutic purposes), the thermal conductivity of water and a particle of 10μ (large microbes) we find an order of magnitude of 10^{-5} degrees for the upper limit. Under the above mentioned assumption, the particle center is at best by some 10^{-5} degrees warmer than its surroundings. In smaller particles or weaker fields the temperature difference is of course still smaller. It was also found that the gradients of temperature are of a normal order of magnitude. Consequently the point heating hypothesis can not explain effects of any kind in short wave therapy. An effect which can not be explained, even under exact temperature measurements, as one of macroscopic heating, is no thermic effect at all, but is non-thermic (specific) in nature.

The following phenomena are instances of specific effects:[4] If a suspension (e.g. blood) is introduced into an electric field, the positive charges in the suspended particles (e.g. in the erythrocytes) are drawn to one side, the negative charges to the opposite side (fig. 1). In this way charges are

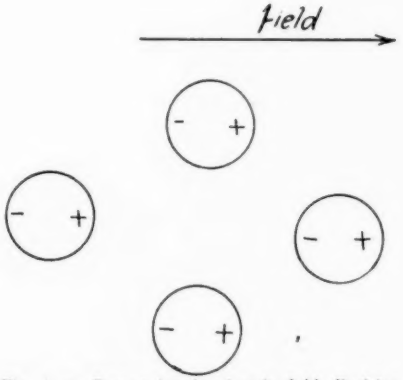

Fig. 1. — Suspension in electric field. Positive charges are drawn to one side, negative charges to the opposite side.

induced on the surface of the suspended particles. The charges induced in various particles exercise forces ("induction forces") upon each other. It can be shown, that these forces try to arrange the particles in the suspensions into pearl chains. The chains follow the direction of the field. They were observed by Denier[5] in a solution of India ink and later were observed by

me with fat drops in diluted milk. Liebesny and Pace have fixed in a film the pearl chains, which are formed in milk, blood and yeast suspensions.[6]

This film shows distinctly, that two phenomena work against this pearl chain formation: 1) Brown's movement of molecules, and 2) convection of heat. The molecules in Brown's movement touch the particles. In order to bind the particles so firmly to each other, that the chains can resist these shocks, a certain minimum of field strength and induction forces is required. For such conditions, as we have with erythrocytes, the minimum field strength is in the order of magnitude of 1/10 V/cm. On the other hand, the field strength must not be too large, for then strong convection currents would result, which would break up the pearl chains. This fact is analogous to (although perhaps not in casual connection with) the effects, which physicians and biologists observe in weaker fields, and which disappear when the fields become stronger. The least chain destroying effect of course is obtained if insulators are used as the medium in which the particles are suspended. Insulators do not grown warm in the field. Picker[7] has made use of the chain formation in order to render the course of the lines of force visible. For the reasons given above, he suspended the particles in benzole, which is an insulator.

In milk, blood and yeast suspensions the particles draw away from each other as soon as the field is switched off. But that need not always be the case. And then the degree of dispersity of the suspension increases. This increase of the degree of dispersity was observed experimentally by Schutz.[8] It is, however, possible that in these experiments other effects cooperate, apart from chain formation. Moreover, gas bubbles may be joined together by chain formation and expelled in this way.

It is likely that there is a chain in a stream and that this stream shows various speeds in different strata. If in this case the chain, i.e. the field, stands normally to the direction of the stream (fig. 2, *A*), the effect of the chain is, that the various strata can not move so easily with a different speed.

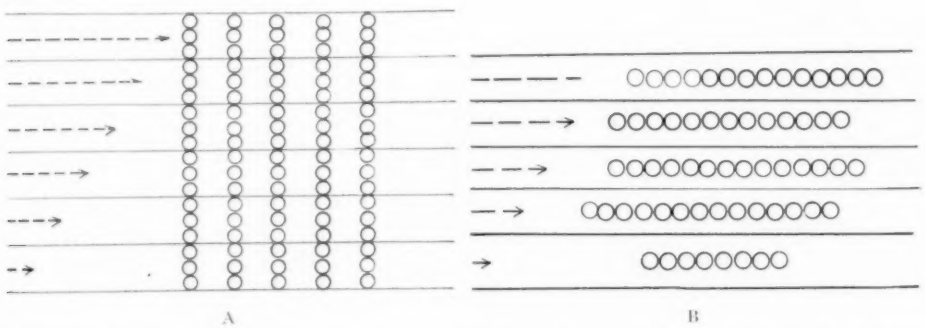

Fig. 2. — Chain formation in a stream. The arrows indicate the magnitude of velocity in the different strata. *A*, the field stands normally to the direction of the stream; *B*, the field stands parallel to the stream.

This effect is equivalent to an increase of the viscosity of the suspension. If, on the other hand, the chain (the field) is parallel to the direction of the stream, (fig. 2, *B*) it has not the above mentioned effect. This dependence of the effect upon the field is a characteristic difference from the thermic effects, which are independent of the direction of the field.

When observing the sedimentation of a particle in a vessel, we find that the other suspended particles exercise forces on the observed particle as soon as the field is switched on. These forces can strengthen or weaken the gravity, and in this way they can increase or decrease the speed of sedi-

mentation. This effect depends on many circumstances, e.g. the field strength, the form and size of the vessel, the diameter of the suspended particles and their distribution in the vessel, the position of the observed particle, and again the direction of the field. With regard to the order of magnitude the effect is not very great, but it should be measurable.

On the surface of a suspension the concentration of the suspended particles differs from that within the suspension. The suspended particles are either drawn to the surface of the suspension by certain forces (capillary forces) or they are repulsed from there by these forces. If a field is switched on, the particles within the suspension exercise forces upon the surface particles. In this way, the capillary forces can be strengthened or weakened. Thus the structure of the surface, the surface tension, and the structure of a membrane, which may form itself on the surface, can be influenced by the field. This effect depends also on the question, whether the field is normal to or runs parallel with the surface. It is, however, not easy to treat this effect theoretically, nor has it yet been sufficiently examined by experiments.

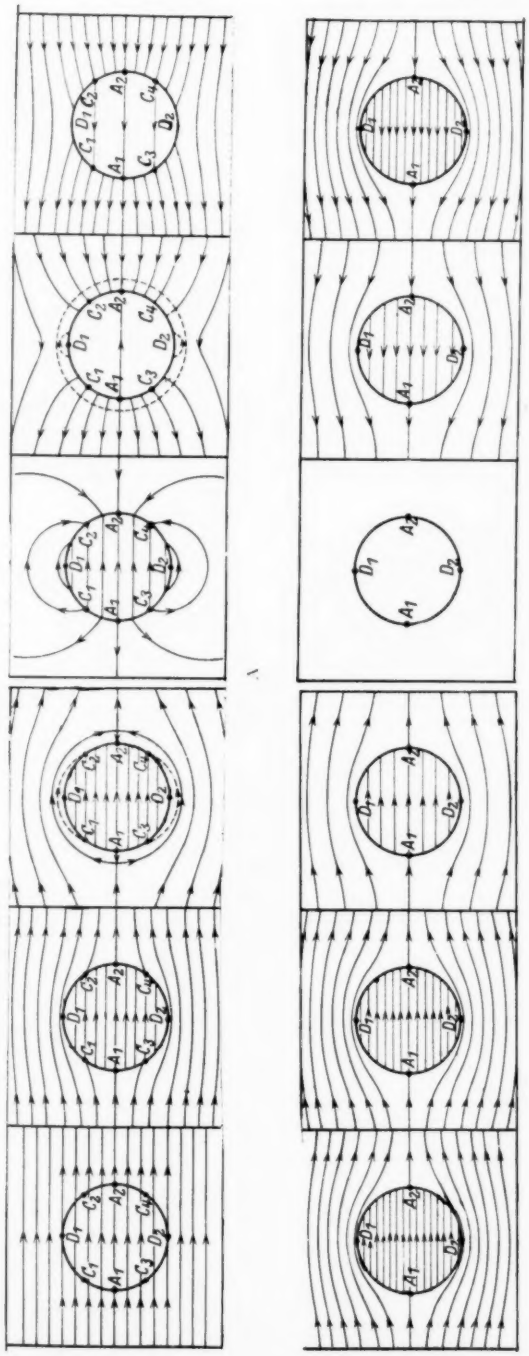

Fig. 3. — Lines of force in a long cylinder. *A*, for high frequencies; *B*, for low frequencies.

All effects of the induction forces depend on the direction of the field and they must therefore take a particular course, if the field direction is not always the same, but makes a full rotation during one period, as is the case in so-called rotating fields. Such fields have, therefore, particular effects. It is an interesting fact that rotating fields can result spontaneously from ordinary alternating fields under certain frequencies and that these frequencies lie within the short-wave

band, if the substances in the field are biologic in character.

Figure 3 shows the course of the lines of force in the surroundings of a very long cylinder, which is placed into a field that originally was homogeneous and normal to the axis of the cylinder.[9] The various figures represent successive twelfths of a period. Figure 3, *A*, represents the course of the lines of force under a very low frequency, while figure 3, *B*, shows the field under an ultrahigh frequency. We see in 3, *A*, that the direction of the field remains unaltered, though the field strength oscillates, which is marked by alteration of the space between the indicated lines of force, while in 3, *B*, the field rotates in the points C_1-C_4 in a certain angle during the six twelfths of a period, so that it has made a full rotation after a full period. Consequently there is a rotating field in these points under ultrahigh frequencies.

The above mentioned non-thermic effects must be considered as specific electrical, but not as specific short wave effects. For the induced charges, the induction forces and their effects depend in their first approximation only on the field strength and the nature of the field (rotating or ordinary alternating), and not on the frequency as such. For this reason the effects just described are also observed with long waves, in which the field strength and the nature of the field depend on the frequency. With short waves they are of an especial quality in contrast to the longer frequencies which are protected by insulating materials and from spontaneous rotating fields. We may therefore assert at least indirectly that there exists a particular state manifested by the above-mentioned effects of the short wave field.

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.·. EDITORIALS .·.

Open Letter to The Surgeon General of United States Army by the President of Our Congress

Dear Sir:

In view of the serious situation abroad and the effort on the part of our Country to be prepared for any emergency, I would like to offer my services and the services of the American Congress of Physical Therapy, of which I am at present the Presiding Officer. If the government has any plans looking towards the utilization of the services of men who have specialized in Physical Therapy, I feel that our society is in a position to offer considerable help in organizing such specialized service.

Knowing the extent to which Physical Therapy was utilized in the last war and is still being employed in government hospitals, I feel that the members of the profession who are interested in this work should be organized in some way to meet any emergency that may arise.

I hope you will call upon me and the American Congress of Physical Therapy, to render whatever service we can in seeing that the profession is prepared, so that unnecessary time will not be lost.

Assuring you of my earnest desire to cooperate, I am

Very sincerely yours,

WILLIAM H. SCHMIDT, M.D., *President*

American Congress of Physical Therapy.

DR. TURRELL'S COURAGEOUS PROTEST

At this moment when arms and men are occupied with barbarism and blood to create cataclysmic disruptions of national and economic structures, apparently only those events that rise to the sublime or plumb the profound in their influence hold attention. And yet the wisdom of the ages as voiced by Lincoln in one of his most poignant addresses — "and this shall also pass" — is a timely reminder that the fundamentals of our medical structure even as life itself must pursue its course though momentarily submerged by ungovernable episodes.

The resignation of the internationally famous dean of British physical therapeutists from his position as honorary consulting physician to the Department of Physical Medicine of the Radcliffe Infirmary, Oxford, an account of which is published elsewhere in this issue,[1] may at first blush ap-

pear as an anachronism to the tragic period through which his country is now passing, were it not that the motive was impersonal, unselfish, and self-sacrificing for a cause that involves the future status and weal of Physical Medicine in England and America. At a time when nations are intensively occupied with death and degradation it may not be amiss to point out that Turrell's stand is no more incongruous as a protest against the injustice of abusive hospital practice in physical therapy than that of any chief executive about to serve his country under gathering clouds. In each instance the courageous protest on the one hand and the promise on the other dealt with a constructive vision for ameliorating existing conditions that threatened to destroy an ancient and progressive branch of medical practice or a nation rich in promise and unswerving to an ideal.

Though compact in size, the open communication of Turrell and the reply of the management of the Radcliffe Infirmary provide a wealth of information of the existing conditions and status of physical therapy in England that had their duplication in America some two decades ago and to no small extent still persist in many quarters. It is precisely because of this situation that the example set by one of the most eminent pioneers in physical therapy merits more than passing comment. It is an open secret diplomatically suppressed in a spirit of appeasement that most members of the staffs of hospitals and similar institutions do not wholeheartedly cooperate with the physicians who are devoting their lives to the development and success of physical medicine.

One of the objections to existing conditions in the Radcliffe Infirmary raised by Dr. Turrell applies with equal force to a considerable number of American institutions. More than one brilliant physical therapeutist has been impelled to sever his connection with the physical therapy department of an otherwise distinguished institution because of the unreasonable demands made on their time without adequate recompense. In this country it is common knowledge that due wholly to such a niggardly and inconsiderate attitude on the part of the authorities of one of our largest institutions the director of the physical therapy department was compelled to sever his connection with the concerned school and hospital because of his utter inability to serve in his capacity as teacher and attending physician under their exactions. The injustice which led to such a step was so flagrant that his entire staff of associates followed suit. It is owing to this event which could be duplicated many times, that Dr. Turrell's unselfish example finds a sympathetic echo in the field of American physical therapy.

The time for considering departments of physical therapy as mere handmaidens of other departments has passed long ago. There is hardly any need stressing the fact that from a purely scientific point of view physical therapy has universal recognition as an established discipline, part and parcel of medical science and practice with the same prestige as that had by internal medicine, surgery and other recognized specialties. This being so, it is the duty and obligation of our Congress as a body politic to exert its efforts toward obtaining for physical therapy all the privileges and emoluments commonly accorded to all other hospital departments.

It is indeed pitiful that in democratic Great Britain, particularly at a time when the very sovereignty of that great nation is struggling to maintain its democratic principles of fair play, a scientist who has grown old in the service to his institution should after twenty-eight years of unusually fruitful labors feels compelled to sever an honorable connection with it because of the continuation of a policy so lacking in vision as to fail to appreciate the progress and worth of the specialty of which he is a brilliant ex-

ponent. Dr. Turrell has rendered by this act a greater service to physical medicine than he probably realized when he took such a courageous attitude. It may well serve as a warning and arouse universal condemnation which certain quarters in their own interest will do well to heed. This should not be interpreted as a direct or implied attack but merely as an illumination of existing, undesirable conditions that should light the way to mutual good will and better cooperation of all concerned. It is truly as Lincoln has said, "and this shall also pass," because in spite of human frailties progress in any science will find its proper level in spite of the frozen conservatism manifest in places where a liberal attitude would prove the best policy to further humanitarian interest.

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MEDICAL EQUIPMENT AND RADIO COMMUNICATION

It is common knowledge that machines for medical and surgical diathermy, the administration of short waves, and some types of roentgenologic outfits produce an interference with radio communication when they are in operation. This at times has proved so serious as to invoke police power to halt the use of the interfering equipment. While now such exercise of police authority is subject to review by the courts, the extent of the complaints against such interference by medical equipment, particularly in the administration of police work, may soon lead the Federal Communications Commission to seek legislation authorizing the correction of any condition that interferes with interstate communication. (Williams, H. B.: Bull. Am. Coll. Surgeons **25**: 74 (April) 1940.)

While the problem is an acute one, Williams wisely cautions that "the whole subject requires study before mandatory legislation is passed." Engineers, of course, must be the ones to whom the solution will be entrusted, but physicians, whose need for these modalities in the treatment of patients is unquestioned, should also have a voice in the shaping of a remedial statute. Every hospital and practically every physician in private practice has one or more of these offending machines, which should have to be scrapped, if, to make an assumption, a definite frequency band were to be arbitrarily assigned for medical purposes. Furthermore, new equipment built to meet such regulation would necessitate crystal control to assure the assigned frequency and devices to suppress harmonics that would make the cost to the doctor twice what it now is. Shielding the room in which radiating equipment is used has proved satisfactory to a degree, even in the reception of television, but those who would undertake such a procedure must realize that many problems relative to electromagnetic shielding are as yet unsolved by the engineering profession.

Medical men are in hearty accord that the disturbance to communication must be eliminated as a safeguard to public welfare. They feel, however, that a method should be devised that will provide for the continuance of medical radiation without making the hospitals and the doctors bear the brunt of the cost. If the Federal Communications Commission recommends any change in the frequencies now employed by medicine, it should follow the example of the utility companies in our nation. Whenever these companies felt that there was an urgent need for a change in service so that the public in general might benefit therefrom, they themselves shouldered the burden, and the individual lost nothing in service or dollars. — Editorial, New York State J. Med. **40**: 617 (April 15) 1940.

CORRESPONDENCE

Dr. W. J. Turrell *

Resignation from Physical Medicine Department of Radcliffe Infirmary, Oxford

Many readers of the *Journal* will be surprised and sorry to learn of the resignation of Dr. W. J. Turrell from the position of Hon. Consulting Physician to the Department of Physical Medicine of the Radcliffe Infirmary, Oxford. We believe that the steps leading up to this will be of interest to those interested in the welfare and advancement of physical medicine, and particularly in its optimal utilization in our hospitals. Accordingly, with the permission of Dr. Turrell, we give below the correspondence which passed between him and the Committee of Management of the Radcliffe Infirmary. The important points raised are so clearly stated as to require no comment from us.

An Open Letter to the Committee of Management of the Radcliffe Infirmary

Gentlemen,

I beg to bring to your notice the following main points urgently calling for an early revision of the organization of the physiotherapy department of the hospital.

1. When I undertook the formation of the electrical department in 1912, the main point that I insisted upon was that the department should be entirely autonomous and that cases might be sent direct to it by the local general practitioners without such cases having previously to pass through any other section of the hospital. This point I maintained, in spite of occasional opposition, until my retirement from the charge of the department in 1939, and I should have resigned my appointment if this privilege had been at any time withdrawn.

My insistence upon this condition was in the first place due to an article on the experiences of a French electrotherapist Dr. Laroquette, who was in charge of the physiotherapy department of the war hospital at Dey, in Algeria, during the Franco-Moroccan war, 1907.

Dr. Laroquette stated (*Archives de l'Electricite Medicale*) that: "The department of physiotherapy forms a division self-governing in the same way as a department of medicine or surgery. It was only by degrees that we obtained this independence, and we attach great importance to it. It is only under such conditions that good and exact work can be done. Each department is thus rendered responsible for its own work."

This contention appears to me to be self-evident and in several papers I have attributed to its observance the successful development of the electrical department at the Radcliffe Infirmary.

The following are the main points that render the observance of the principle so essential to the maximum efficiency of the department:—

Any medical man should be entitled to send cases direct to the electrical department without passing them through a medical, surgical or other section. Often the delay occasioned by passing the patients through other departments will greatly prolong the treatment required. Moreover, by the imposition of this restriction an uncalled-for slur is cast upon the diagnostic powers both of the general practitioner and the medical man in charge of the department. The prestige of the department is also thereby appreciably lowered.

But perhaps the most important point is that the opportunity for research into the application of electrical methods to the treatment of disease is seriously diminished by such a restriction. For instance, if the medical man in charge of the department is investigating the effects of any electrical treatment, he should be in a position to ask medical men engaged in general practice to send him for investigation cases of the diseases upon which he is conducting his research. Experience has shown that individualistic research uncontrolled by committees or other authorities, is by far the most productive.

The absurdity of this restriction is evident when we realize how few medical men have any knowledge of the nature, action, and indications for electrotherapy.

2. The medical officer in charge of the physiotherapy department should be a member of the staff committee. It is difficult to see why he should be excluded from this committee on the pretext that he receives a salary of £400 per annum, when some members of the committee receive a salary of £2,000 per annum. By this exclusion both the efficiency and prestige of the department are adversely affected.

3. Patients attending the electrical department should be restricted by the same income limit and should satisfy the almoner regarding their means in the same way as patients attending other departments of the hospital.

It is evident that the reduced fees charged for electrical treatment at the hospital can only be employed if the overhead charges, such as treatment rooms, salaries of masseuses, rates, light, electricity, capital and interest on outlay, etc., are provided out of funds which have been charitably subscribed. It is, therefore, obviously unfair that private patients, capable of paying ordinary fees, should partake in part of charitable contributions subscribed for the aid of poor patients, and should thereby be relieved from the payment of adequate fees to the private practitioners of electrotherapy. The inconsistency of the attitude of the honorary staff to the unrestricted income limit for those attending the electrical department is well exemplified by the vigour with which some of its members opposed the Nuffield

* Reprinted from the Brit. J. Phys. Med. **3**:96 (May) 1940.

professors being permitted to engage in private practice. There is obviously more justification for retaining the valuable services of these distinguished medical men, remunerated from a source apart from the hospital, for the assistance of the suffering public, than for utilizing the services of a salaried officer of the hospital to compete at unremunerative fees with equally well qualified practitioners unconnected with the voluntary hospital — remuneration by fees extracted from those who are well able to afford the fees of those practising electrotherapy in a private capacity.

In extenuation for the length of this indictment, I would point out that it might have been unnecessary, if, as consulting physician to the physiotherapy department, and with the experience gained in 27 years in charge of the electrical department, I had been consulted in the slightest degree in reference to the revolutionary innovations that I have indicated.

I have the honour to remain,
Your obedient servant,
(*Signed*) W. J. TURRELL.
Honorary Consulting Physician to the Department of Physical Medicine.

In reply to this letter Dr. Turrell received a communication from the committee of management to the effect that, in the light of opinions expressed by the honorary medical staff of the hospital, they were not inclined to change the present regulations dealing with the reference of patients to the assistant physician in charge of the department. There was no reason why the assistant physician, though he could not at present be regarded as a member of the honorary staff, should not be called into consultation by the honorary staff for discussion of departmental affairs. An examination of the numbers of treatments given, and of patients treated, in the department during the past three years revealed the fact that, even after deduction of paying patients, there was a large increase in the volume of work done in respect of ordinary patients. A proportion of the time of an additional masseuse, who had been appointed to meet the extra work entailed by the treatment of private patients, was available for ordinary patients. The committee were therefore of the opinion that there was no basis for the suggestion that ordinary hospital patients had in any way suffered as a result of the treatment of private out-patients.

To this Dr. Turrell replied as follows:

Cherwell Lodge,
Oxford.
March 11th, 1940.

To the Administrator,
Radcliffe Infirmary.

Dear Sir,

The uncompromising nature of the reply of the committee of management of the Radcliffe Infirmary to the criticisms, contained in my letter of January 19th, of the present organization of the electrical department of the hospital leaves me no alternative but to sever my connection with the Radcliffe Infirmary.

I take this step with the greatest reluctance, for I have been most pleasantly and advantageously associated with the hospital as a "perpetual student" since 1887, as house surgeon, 1890 to 1892, besides forming the electrical department in 1912, and remaining in charge of it till 1939: during which time I secured for it international recognition.

I cannot, however, allow my name to be associated in an official capacity with a hospital which, in my opinion, adopts a policy most prejudicial to the advancement of electrotherapy and most destructive of private practice in that specialty. I would, therefore, ask you to take the necessary procedure for the removal of my name from the list of honorary consultants to the Radcliffe Infirmary.

I would like it to be most clearly understood that I take this step in no hostile spirit to the hospital and most certainly in no way antagonistic to the electrical department, which I am confident will continue its successful progress under the able direction of my successor, however much he may be hampered in his work by the subservient position in which he is placed in relation to the members of the hospital staff.

I would much prefer my resignation to be regarded as a gesture against the jealousy, and ignorant prejudice of certain medical men, who entirely ignorant of the first principles of electrical treatment, oppose its development by every means in their power. In this aspect of the question the origin of our present difficulties can be found, and the only means by which the recurrence of such troubles can be prevented is by the inclusion of physical medicine in the medical curriculum of the student, so that medical men may have at least some elementary knowledge of a subject upon which they at present pronounce judgment so ignorantly yet so peremptorily and with such assurance.

But this is perhaps beyond the scope of the present communication.

Yours faithfully,
(*Signed*) W. J. TURRELL.

SCIENCE, NEWS, COMMENTS

Lectures on Physical Therapy in State of New York

The council committee on public health and education of the Medical Society of the State of New York sponsored a course of lectures in physical therapy for St. Lawrence County Medical Society, Ogdensburg, and the Jefferson County Medical Society, Watertown. The speakers were:

Dr. *William Bierman*, New York, Therapeutic Use of Ultraviolet Radiation; Physical Therapy in Medical Conditions, April 25; Dr. *Kristian G. Hansson*, New York, Physical Therapy in Traumatic Conditions, May 16; and Dr. *Richard Kovács*, New York, The Therapeutics of Heat; Medical and Surgical Diathermy; Physical Therapy in Arthritis, April 18; Galvanic and Low Frequency Currents Electrodiagnosis; Physical Therapy in Gynecology, May 2.

Dr. Titus Guest Speaker at Election Meeting of Pennsylvania Physical Therapy Society

Dr. *Norman E. Titus* discussed technic of short wave diathermy at the Pennsylvania Physical Therapy Society on May 14. This session was held in conjunction with the Lehigh County Medical Society in Allentown. At this meeting the annual election of officers was held with the names of the following men filling the offices:

Dr. *Earl Rothermel*, Reading, Penna., President.
Dr. *B. Ulanski*, Philadelphia, Vice-President.
Dr. *J. H. Hennemuth*, Emaus, Penna., Treasurer.
Dr. *A. A. Martucci*, Abington, Penna., Secretary.

Trichinosis Danger May Be Eliminated by New Inspection

A practical plan for the eradication of dangerous trichinosis, at a cost of from 25 to 50 cents per pig slaughtered, was presented by Prof. Thurlow C. Nelson, of Rutgers University, before the meeting of the American Association for the Advancement of Science. The plan depends on widespread use of a new, simple skin test for trichinosis developed by Drs. G. W. Bachman, D. L. Augustine and Hans Theiler. It has been used successfully by the New York City Health Department during the past 18 months.

"Every seventh to tenth garbage fed pig slaughtered in this country today is wormy, infected with the most dangerous worm known to man," Prof. Nelson declared.

Humans eating the meat of such animals, unless it is thoroughly cooked, may develop the serious and often fatal malady, trichinosis. Federal health service estimates show that the trichinosis problem involves some 17,000,000 people, several hundred thousand of them suffering the disease, and probably several thousand dying from it every year.

By Prof. Nelson's plan the new skin test would be made of every hog slaughtered, both in commercial packing houses and on farms slaughtering for home and local consumption. The cost of this, once arrangements are made, need not be more than 50 cents per animal, and may be as low as 25 cents. The New York experience with the test shows it is accurate to within less than 3 per cent, and the error is in the direction of safety, since with one exception all the mistakes made were diagnoses of trichina infection where it did not exist. — *Science News Letter.*

Vaccination for Birds

Vaccination against malaria, in birds, but unfortunately not in man, was announced by Dr. W. B. Redmond, of Emory University, Atlanta, Ga. Whether the method can be applied to human malaria was not stated in Dr. Redmond's report of his work.

The successful vaccine was prepared by killing the malaria parasites of germs in the red blood cells without destroying these cells. This was accomplished by subjecting the cells with the germs in them to subzero temperature in a solution of urea and sodium citrate. — *Science News Letter.*

Plants Poisonous to Pest

The bragging old cowboy song, that modestly states, "Rattlesnakes came out and bit me, and then crawled away and died," finds realization for greenhouse plants when they are given two or three parts of the poisonous element selenium per million of the nutrient solution in which they are grown. Such plants are completely freed of the attacks of red spider, one of the worst of greenhouse pests, yet show no ill effects in their own growth, it was stated in a report presented jointly by Drs. V. H. Morris, C. R. Neiswander and J. D. Sayre of the Ohio Agricultural Experiment Station. — *Science News Letter.*

Tear Gas for Tomatoes

Disagreeable as it is to human beings, tear gas (chloropicrin) is very good for tomatoes, when used as a soil fumigant. Tomatoes thrive amazingly in soil that has been thus treated. Drs. Fred K. Crandall and Frank L. Howard of the Rhode Island Agricultural Experiment Station related how tomatoes raised on chloropicrin-treated soil increased their yield by 132 per cent in 1937, by 378 per cent in 1938, and by 246 per cent in 1939, as compared with check plants grown on untreated soil. — *Science News Letter.*

Stored Fruit Loses Vitamin

Tangerines kept in storage too long lose a considerable part of their value as source of vitamin C (ascorbic acid), Dr. Cyril O. Bratley of the U. S. Department of Agriculture stated. In his experiments, numbers of the fragrant citrus fruits were kept in storage for eight weeks at various temperatures. Loss was greatest at the higher temperatures: one-eighth of the vitamin vanished at 32-33 degrees Fahrenheit, but at 45-48 degrees the loss rose to one-third. — *Science News Letter.*

Slowed Down Neutrons Are More Effective for Cancer

Slow neutrons from the atom-smash-cyclotron, of the kind used in the spectacular splitting of the uranium atom, are five times as effective against cancer as the fast neutrons which are already showing promise as anti-cancer weapons, it was announced at the University of California.

The new, slow-neutron attack on cancer is far from the stage of being used in treatment of human cancer sufferers. It was developed in test-tube experiments with cancer tissue removed from the body by Dr. P. G. Kruger, of the University of Illinois, working with the University of California's cyclotron.

In the new process, fast neutrons coming from the cyclotron are slowed down by passing through a thick block of paraffin. These slow neutrons then enter a test-tube containing cancer cells in a solution of boric acid. The boron atoms of the boric acid capture neutrons which break down the boron into helium and lithium. These fly off and lose their energy in the malignant or cancer tissue and in so doing, destroys its malignancy.

It is possible that the effectiveness of boric acid lies in the very large capture cross section of boron atoms for slow neutrons. This has been demonstrated many times and, in fact, hollow cylinders of boron are used to produce collimated beams of slow neutrons. Only neutrons going through the hole pass through. The others are captured and stopped by the boron atoms. — *Science News Letter.*

Plants Absorb Hydrogen; Use It in Life Processes

Hydrogen absorption by plants, something never before observed, was reported by Dr. H. Gaffron of the University of Chicago. The plants able to perform this unique feat are one-celled algae, know to botanists as *Scendesmus.* Kept in an atmosphere of hydrogen in the dark, they absorb the gas and use it in various ways in their life processes. In dim light, they combine hydrogen with carbon dioxide to form food materials. However, if the light becomes too strong, they stop absorbing hydrogen and return to the normal process of combining carbon dioxide with water, giving off oxygen as a by-product. — *Science News Letter.*

Possible Cure Hinted for Nervous Breakdown

A method of curing nervous breakdowns in rats, that may contain a hint of useful methods for treating human mental trouble, was reported to the American Association for the Advancement of Science in Columbus by Dr. Norman R. F. Maier, University of Michigan psychologist who last year won the thousand-dollar AAAS prize for merely producing nervous breakdowns experimentally in rats.

The trick in Dr. Maier's cure for neurotic rats is to encourage them to find something to do even though it fails to solve the conflict that confronts them. He calls this "abortive behavior." Rats forced to act in a manner which they have learned is wrong suffer nervous disorders. Dr. Maier, to cure them, trained them to just make a halfway jump toward solving their dilemma.

Translated into human applications, this is the way Dr. Maier's new therapeutics, at present tried intensively only on two rats, might work out:

A man driven by hunger of his children to steal bread but prevented by honesty might have a nervous breakdown. If he makes a clumsy and unsuccessful attempt to steal, his mind would be restored.

A girl urged by her parents to marry might dislike both of two available suitors. Forced to marry, she would break down. If she engages herself to one but is cold to him, so that they drift apart, she is saved. A substance activity, such as a career of nursing, would serve the same purpose.

Occupational therapy in a mental hospital serves to fill this need for substitute or partial activity. — *Science News Letter.*

"Pep Pills" Fight Sleep Through Brain Respiration

So-called "pep pills" of benzedrine, resorted to, sometimes dangerously, by college students for wakefulness during cramming sessions, owe their sleepfighting effect to their influence on brain respiration, Drs. P. J. G. Mann and J. H. Quastel, of Cardiff City Mental Hospital, report. (*Nature,* Dec 2.)

Benzedrine has "unquestioned value," the Cardiff doctors point out, in the treatment of narcolepsy, that strange condition in which the patient is seized, often at inconvenient and even dangerous times, with an uncontrollable desire to sleep. The condition is also known as paroxysmal sleep or sleep epilepsy.

Chemical studies by the Cardiff scientists suggest that benzedrine may fight this condition by retarding the formation of poisonous substances such as aldehydes which depress the respiration or oxygen uptake of the brain. Benzedrine does retard aldehyde formation, Drs. Mann and Quastel found. The next step will be to determine whether these or similar substances accumulate in the brain of patients with narcolepsy.

The Cardiff studies were made on brain tissue outside the body to which a chemical called tyramine was added. Tyramine and most other chemi-

cals belonging to the amine group greatly diminish brain respiration or oxygen uptake. When benzedrine is added, this effect is neutralized.

Slowing of brain respiration is not so much due to the presence of tyramine itself as to accumulation of aldehyde. This chemical, highly poisonous to respiratory processes in the brain, is formed from tyramine or other amines by the action of an enzyme. Benzedrine also combines with this enzyme, but no aldehyde is formed from this combination. In the competition with benzedrine for the enzyme, tyramine comes off second best, the Cardiff studies showed, with the result that aldehyde formation is checked, and there is no slowing of brain tissue respiration. — *Science News Letter.*

Rub Sex Chemicals on Gums to Prevent Loss of Teeth

Just as women now rub cold cream on their faces, both men and women may soon be rubbing their gums with sex hormone chemicals in order to strengthen them and prevent loss of teeth.

Experiments by Dr. Daniel E. Ziskin of Columbia University's School of Dental and Oral Surgery show that sex hormone preparations treat successfully diseases of the gums by "armor plating" the gums through a strengthening of the outer protective portion or keratin layer.

Men should use male sex hormones for best results, and women should use female sex hormone, but either hormone on either sex is effective.

Keratin is a horny substance which when present in normal deposits serves to protect the mouth against infection. The sex hormone treatment is used to supplement other treatment, but succeeded in some stubborn cases that were not helped by any other method.

"The keratin layer is necessary," Dr. Ziskin explained, "to maintain healthy gums, and may be lost or reduced in thickness in the presence of certain irritating factors. Such loss or reduction lowers resistance to bacteria which ordinarily could not penetrate, and opens the way for more serious involvements.

"Loss of keratin may result from local causes, such as tartar on the teeth, or from causes originating within the body, as for example, pregnancy."

"The new method does not promise to be a cure for tooth decay since gum disorders are not necessarily either the cause or the effect of diseases of the teeth. However, the presence of irritating factors in the teeth, such as tartar or cavities, can bring about inflamed gums. In so far as the gums are concerned, the application of sex hormones will be of assistance in the treatment of dental disorders." — *Science News Letter.*

Role of Exercise in Cardiac Disease and Edema — Sussman

(Continued from page 328)

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BOOK REVIEWS

MANUAL OF PERIPHERAL VASCULAR DISORDERS. By *David W. Kramer,* M.D., F.A.C.P. Assistant Professor of Medicine, Jefferson Medical College, Assistant Physician Jefferson Hospital. Chief Clinical Assistant, Vascular Clinic, Jefferson Hospital. Visiting Physician, Medical Division, Philadelphia General Hospital. Cloth. Pp. 448. Price, $6.00. Philadelphia: P. Blakiston's Son & Co., 1940.

Although the literature is replete with publications dealing with disturbances of the peripheral blood vessels, there is an actual need for a well organized and comprehensive monograph which presents all aspects of the concerned problems under one cover. The principal difficulty encountered by young practitioners and those who have no opportunity to see and study many cases of this type is the differential diagnosis. From this and other points of view the author has excellently fulfilled the task of proving a valuable teacher and guide in perplexing situations. The book is divided into four special parts of no less than 21 chapters to which are added 126 well executed illustrations of diagnostic and therapeutic instruments, macroscopic and microscopic pathologic processes and a number of charts illustrating the effects of various treatments. Beginning with a brief historic sketch, Kramer takes up the various symptoms, methods of examination, functional tests and follows this with clinical studies. These he groups as occlusive vascular disorders, vasospastic and vasodilator disorders, and concludes with gangrene and disorders of the veins. Each of these main groups contains a number of chapters dealing with the various clinical entities. The author properly evaluates all known physical therapeutic measures, some of which are discussed at great detail, but the indications for medical regimens and surgical intervention, too, are described in a satisfactory manner. There can be no doubt that the book offers every study and advance made in this field down to date. The excellence of the text is enhanced by large type on paper which renders perusal a pleasure. We predict that the author will be rewarded by obtaining a large audience by his colleagues who are interested in perfecting their diagnostic acumen and therapeutic management of disturbances and organic affections of the peripheral circulation.

TOMOGRAPHY. By *J. B. McDougall,* M.D. (Glasg.), F.R.C.P. (Ed.), F.R.S.E. Fellow of the Royal Faculty of Physicians and Surgeons, Glasgow, etc. Cloth. Pp. 71 with 110 illustrations. Price, 21s net. London: H. K. Lewis & Co., Ltd., 1940.

This volume offers a rich series of sectional radiographic studies of the chest in the form of halftone illustrations under the term tomography, a term that has in the past been described by some as x-ray focusing to produce plani-, strati-, or laminographic shadows that enhance diagnostic detail especially for conditions associated with diseases of the thorax. Difficulties in the presence of bony structures forming the thoracic cage, thick scapulae, well formed pectoral muscles, mammary glands in the females and the like, often tend to reduce the translucency of normal lung tissue in x-ray films, especially when it is appreciated that the presence of the shadows of the ribs and its crossing cover approximately two-thirds of the lungs. One can enumerate the mounting difficulties encountered in the study of translucent organs and the confusion arising from the superimposition of structures of varying densities, but of greater interest is the means of obviating this difficulty. Accordingly this exposition in the form of an album depicting 110 illustrated examples with accompanying explanatory notes of abnormal conditions of the lungs, must be regarded as a timely contribution. While it is in no sense presented as a substitute for routine x-ray examination and screening, these flat pictures add to the elucidation of the problem, especially to the problems of pulmonary tuberculosis. The detail elicited by this means should be the reason for adoption of this valuable method because it offers a wealth of information not provided nor suspected in even the clearest of films. For the student of radiology and specialist in diseases of the chest, this volume shows the scope and indicates the possibilities of tomography. It discusses the difficulties in interpretation of chest films, the advantages of tomography over stereoscopy, its geometrical principles, technic of examination, and concludes with a summary that points out its scope and limitations. The appended bibliography is well selected and rich in source. The volume is a splendid example of conservative evaluation of an important feature of radiologic development in the field of diagnostics.

TUMORS OF THE SKIN, BENIGN AND MALIGNANT. By *Joseph Jordan Eller,* M.D., Attending Dermatologist, City Hospital, New York; Consulting Dermatologist, French Hospital, Broad Street Hospital, New York; Morristown Memorial Hospital, Monmouth Memorial Hospital, Pitkin Memorial Hospital, New Jersey; Norwalk General Hospital, Connecticut; Unity Hospital, Brooklyn; Morelos Hospital, Mexico, etc. Cloth. Pp. 607. Price, $10.00. Philadelphia: Lea and Febiger, 1939.

The author has devoted much time and effort to the special study of benign and malignant tumors of the skin and mucous membranes, and the fruits of his labors are presented in textbook form. While accessible growths are commonly observed by many general practitioners there is no doubt that certain more or less infrequently seen growths of the skin present diagnostic as well as therapeutic difficulties.

Study of this monograph, which has no less than 403 engravings, will undoubtedly enable even non-specialists to overcome many difficulties. The text is well organized, for after the first chapter dealing with etiology, definitions and classifications in a general sense, the remainder of ten chapters is divided into two groups, six being devoted to benign and four to malignant neoplasms. An appendix presents numerous discussions and tables concerning the therapy by all forms of radiation. There is not a known external benign growth that has been omitted, while this group includes such rarely seen conditions as pseudoxanthoma elasticum, milker's nodules, arsenical keratosis, syringoma, to mention but a few. Carcinoma, malignant melanoma and the leukoses are the subjects taken up in the second part, with the last chapter describing cutaneous surgery and plastic repair of skin growths. Each subject is described from the standpoint of etiology, pathology, diagnosis and treatment. Electrosurgery, especially in the form of electrocoagulation, is mentioned in many instances, though the technic is at times merely indicated. As already alluded to a whole chapter is devoted to excision by scalpel and the creation of various grafts for purpose of repair. The indications for irradiation are given with great care and a good deal of space is devoted to its various technics, which even radiologists will read with profit. The illustrations are splendidly executed and reveal the richness of the material at the disposal of the author. The format of the monograph leaves nothing to be desired, so that all in all the book is a valuable contribution to the literature on accessible neoplasms.

CARE OF POLIOMYELITIS. By *Jessie L. Stevenson*, A.B., R.N., Consultant in Orthopedic Nursing, National Organization for Public Health Nursing; Associate Editor, The Physiotherapy Review; Formerly Supervisor, Orthopedic Division, Visiting Nurse Association of Chicago; Formerly Instructor in Physical Therapy, Northwestern University Medical School. Cloth. Pp. 230. Price, $2.50. New York: The Macmillan Company, 1940.

Considering the aim of this book which appears to be intended for nurses and for families of afflicted persons so as to enable them to carry out home care in the convalescent stage of poliomyelitis, the author has presented an able review of the concerned problems. Written in a style which should be lucid even to laymen and lay women, the author has gone beyond the technical aspect of the nursing care of patients. In five chapters she has described the social interest and the economic conditions involved, the acute stage, the care of convalescents, physical therapy, and functional restoration. She properly stresses that underwater treatment is not the panacea commonly accepted by those who have become interested in the disease through the circumstance that one sufferer rose to the Presidency of the United States. She gives detailed descriptions of massage and exercises and in this regard demands that technicians possess the qualifications exacted by the American Registry of Physical Therapy Technicians. At the end of the volume there is an appendix containing descriptions for the making of splints and of corsets and of devices for moving patients from their beds to underwater tanks. There are 40 illustrations of methods of treatment and of mechanical devices. Forewords by Drs. Ludvig Hektoen and Philip Lewin endorse the text as reliable for all desiring information on the care of poliomyelitis.

THE 1939 YEAR BOOK OF OBSTETRICS AND GYNECOLOGY. OBSTETRICS. Edited by *Joseph B. De Lee*, A.M., M.D., Professor of Obstetrics, University of Chicago Medical School, etc.; GYNECOLOGY. Edited by *J. P. Greenhill*, B.S., M.D., F.A.C.S., Professor of Obstetrics and Gynecology, Loyola University Medical School, etc. Cloth. Price, $2.50. Pp. 736 with 123 illustrations. Chicago: The Year Book Publishers, 1940.

The current volume on obstetrics and gynecology maintains the same high standard as those previously issued under the names of De Lee and Greenhill. The reader will here not only have access to a digest of 632 selected articles accompanied by many of the original illustrations but also will have the benefit of instructive editorial comments from both the American dean of obstetrics and his brilliant pupil and former associate. As in the past, Dr. De Lee divides the presentation of his section under the headings of pregnancy, labor, puerperium, and the new born. Selected for their practical and promising value are abstracts on new tests for pregnancy, discussions on the latest concepts in roentgen pelvimetry, the role of hormones in certain conditions of pregnancy, and the status of vitamin K and its effect on clotting time of the new born. These are only a few of the many interesting contributions of the past year's literature recorded in these pages and can only hint at the richness of this source. The section on gynecology likewise merits praise for its excellence. The literature on sterility and contraception offers many new ideas. The review of operative technic illustrated profusely is an invaluable aid. The chapter on endocrine disturbance is, as heretofore, presented with such thoroughness that those interested in this phase of female disorder must carefully read and digest the material presented. No less can be said for the review concerning the new literature on neoplasms. All in all this year book must be a part of the doctor's library if he wants to keep abreast with the progress of 1939 in these fundamentally important branches of medicine.

INTERNATIONAL ABSTRACTS

Cerebral Symptoms in Fever Therapy. Oscar T. Wood, and Augustus McCravey. J. A. M. A. **114**:1437 (April 13) 1940.

It is important to recognize the early symptoms and signs of cerebral anoxia, edema and hyperemia incident to artificial fever therapy, for serious and permanent brain damage may result from dangerous phases of these. During the course of hyperpyrexia, certain physiologic changes stand out. Due to peripheral vascular collapse, the induction phase is marked by mild circulatory embarrassment consequent upon a rapid drop in the cardiac ventricular filling time. The latter actually becomes shorter than the emptying time, which drops only slightly. The compensatory phase takes place at from 103 to 104 F. and there is less circulatory embarrassment. Diastolic pressure falls rapidly, and is often completely abolished. Increased meningeal permeability occurs during the course of high fever, and can be proved by determination of the bromide quotient. The authors studied cerebral hydrodynamics in 4 cases subjected to a total of 12 fever therapy treatments. The patients had varied disease conditions (chorea, multiple sclerosis, syphilis of the central nervous system) and were of various ages. Electromagnetic induction was used to produce hyperpyrexia. Blood pressure, pulse pressure, pulse rate, respiratory rate and mental state were noted every 15 minutes during the course of fever. Spinal puncture with pressure and volume determinations was done at 104 F. Immediately after spinal puncture, temperature, pulse rate, respiratory rate, blood pressure, pulse pressure, and mental state were recorded.

The authors report an increase in spinal fluid volume and pressure relationships due to increased meningeal permeability which produces a compensatory elevation of the systolic blood pressure, and, in turn, pulse pressure. Manometric determinations show a definite increase in cerebrospinal fluid pressure and volume, but a more accurate index of cerebral anemia is the volume of cerebrospinal fluid. This series of cases shows a surprisingly high pulse pressure, strongly paralleling the observations made in acute cerebral trauma and wet brain, in which it has been shown to be related to cerebral anoxia. The double mechanism of peripheral vascular collapse causing low systolic pressure and a compensatory elevation of systolic blood pressure is found in patients subjected to hyperthermia. The authors have found the pulse pressure to be the best clinical index of the state of cerebral circulation. The normal pulse pressure has been considered as 40. Stupor and drowsiness characterize the clinical status. These signs are interpreted as being due to cerebral anoxia, the result of an increase in cerebrospinal fluid volume and decrease in cerebral blood volume. The spinal pressure may not be decreased. It is not a direct index of the amount of anoxia present. Cerebral anoxia can be relieved by properly timed and sufficient removal of cerebrospinal fluid, that is, from 15 to 20 cc. Such reduction in spinal fluid volume increases the blood volume circulating through the brain and is followed by a prompt fall of the pulse pressure to normal. The salient feature noted is the dramatic clinical change produced by disturbance of intracranial volume-pressure relationship. The depth of stupor was proportional to the height of pulse pressure. After spinal drainage, the stupor was abolished, pulse pressure resumed its normal level, and the patient was more alert. When a complete spinal drainage preceded fever induction, the opposite picture supervened. The importance of stabilizing intracranial volume-pressure relationships in fever therapy is obvious.

Electrosurgical Operation in Gallbladder Diseases: Results of Thirteen Years' Experience. B. O. C. Pribram.

Lancet **2**:927 (Oct. 28) 1939.

The excellent healing obtained through accurate covering of the liver bed with peritoneum after subserous cholecystectomy without drainage led Pribram to seek similar results in more advanced cases in which, owing to partial neurosis, advanced inflammation or scars, an exact subserous cholecystectomy (with knife or with scissors) was no longer possible. His idea was to destroy the inflamed mucosa and the inner layers down to the serosa from the inside thus keeping the serous layer available for covering the hepatic bed with peritoneum. He started these experiments in 1922. At first he used the thermocautery but in 1926 began to use electrocoagulation, which is more quickly and more easily performed than thermocauterization. He described his technic. Summarizing the advantages of the electrosurgical operation he stresses the following points: (1) It is especially valuable in cases of bad infection; (2) the healing tendency in these cases is as perfect as in simple cases; (3) closure of the abdominal wall without drainage is almost always possible when the process is limited to the gallbladder, and (4) electrocoagulation is the best method of dealing with abscesses of the liver in general. With electrosurgical methods there is no difference in the results, whether operation is undertaken in very acute stages of serious inflammation there is no need to perform cholecystostomy as an emergency operation. Radical mucoclasis is performed at the same stage with an even smaller risk and lasting results. Analyzing more than 1,000 cases in which the electrosurgical operation was performed, the author found that the mortality was under 3 per cent. The electro-

surgical operation and the ether method, combined with cholangiography, are his mainstays in dealing with gallstones and hepatobiliary diseases. — [J. A. M. A. **114**:93 (Jan. 6) 1940.]

Effect of Fever Therapy on Carbohydrate Metabolism. M. B. Kirstein and L. Bromberg.

J. Lab. and Clin. Med. **25**:7 (Oct.) 1939.

Kirstein and Bromberg declare that hyperglycemia during fever therapy is not due to blood concentration but to disturbances in carbohydrate metabolism. This concept may have an important bearing on the preparation of patients for hyperpyrexia, especially diabetic persons. One of the important pathologic factors in diabetes is the tendency toward an increased rate of glycogenolysis in the liver. If any factor which stimulates glycogenolysis (such as artificial fever) is superimposed on this, the result may be excessive hyperglycemia, glycosuria and frequently ketosis. (This may also explain the response of persons with diabetes to infectious fevers.) The vicious process can be combated by means of adequate administration of carbohydrates and by inhibiting the rate of glycogenolysis with insulin. — [J. A. M. A. **113**:2353 (Dec. 23) 1939.]

Plethysmography of Skin in Investigation of Peripheral Vascular Diseases. Robert H. Goetz.

Brit. J. Surg. **27**:506 (Jan.) 1940.

The different methods which measure changes in the bloodflow of the skin can be divided into the following groups according to the underlying principles: (1) Methods of the transmission type; (2) methods which make use of photo-electric effects; (3) di-electrographic methods. Changes in the whole volume, however, can mainly be taken as being due to those in the blood content of the capillary bed and the smaller veins, especially the venules. It is known that normally in the capillaries, with systole and diastole, changes occur only in the speed of the blood flow, and only in pathologic conditions is a real capillary pulse traced, while in the smallest arteries, volume changes are met during systole and diastole. For the investigation of peripheral vascular diseases, tests employed in the investigation of the physiology of the peripheral circulation, are applied, and the evaluation of the results so obtained is compared with the normal. The method is essential (1) in differentiating between functional and organic obstruction of the blood flow of the limb, or in assessing the relative degrees of both in a mixed case. Therefore it is an important help in establishing (2) the correct diagnosis, and (3) the prognosis of these cases. At the same time (4) it presents clear indications as to treatment. It could be demonstrated that pathologic changes might even be recorded before any notable clinical manifestation could be detected. Thus the method partly competes with skin temperature measurements. The plethysmographic record, however, is capable of furnishing much more detailed information about the state of the circulation in a given area, and is always able to furnish results even when no changes in skin temperature can be traced.

Comparison of Some Respiratory and Circulatory Reactions of Athletes and Non-Athletes. Edward C. Schneider, and C. B. Crampton.

Am. J. Physiol. **129**:165 (April 1) 1940.

When the minute-volume of breathing is stated in terms of square meters of skin surface or in terms of the ventilation equivalent, the economy of the breathing of the athlete is emphasized. The athlete and non-athlete during rest and moderate exertion consume approximately equal amounts of oxygen per square meter of body surface. They also withdraw equal amounts of oxygen from a liter of blood. The clearest circulatory gains that result from a period of physical training are a reduction in the frequency of heart beat and an increase in the output of the heart per beat. The minute-volume of circulation, when stated in terms of skin surface, seems to be approximately the same for athletes and non-athletes. The oxygen pulse, when stated in terms of skin surface, gives a good index of the differences in heart stroke as found for the athlete and non-athlete.

Pathognesis of Hemorrhage in Artificially Induced Fever. Sloan J. Wilson, and Charles A. Doan.

Ann. Int. Med. **13**:1214 (Jan.) 1940.

Artificially induced fever has attained a definite place among modern therapeutic procedures. Hyperpyrexia, however, is attended by actual, as well as by potential dangers, as is usually the case with any powerful therapeutic agent. Tissue injury from prolonged or excessive exposure to heat has long been recognized. Two of the most constant pathologic findings under such circumstances have been acute liver damage and hemorrhage.

The authors reached the conclusion that a decrease in prothrombin and fibrinogen occurred secondary to liver damage. A decrease in prothrombin may occur without a decrease in fibrinogen. Artificially induced fever resulted in a relative and absolute thrombocytopenia. The megakaryocytes in the bone marrow showed definite cytoplasmic and nuclear damage. The degree of thrombocytopenia depended upon the extent of the megakaryocytic damage. The pathogenesis of hemorrhage in artificially induced fever may be followed in orderly sequence: the elevation of body temperation results in anoxia and a depletion of liver glycogen; these factors may result in hepatic and megakarocytic damage following which there is a decrease in prothrombin and circulating platelets. Fibrinogen may also be decreased. Any decrease in these factors important in the coagulation of blood, contributed to

potential or actual hemorrhage. Regeneration of the damaged parenchymatous tissues apparently takes place quite promptly and completely, the changes being reversible within the usual limits of therapeutic application. Any lack of appreciation of the full significance, however, of the fact of mineral, carbohydrate, oxygen, vitamin and water metabolism in fever therapy might lead to irreversible changes and serious permanent damage or death.

Tuberculous Laryngitis. R. Scott Stevenson, and F. R. G. Heaf.

Brit. M. J. **4126**:167 (Feb. 3) 1940.

The authors have employed a Kromayer lamp, with a Beaumont's curved quartz laryngeal adapter. This is passed over the epiglottis (anesthetized at first with a spray of 5 per cent cocaine) so that the end of the quartz rod which emits the rays is well in the larynx. Exposures start with one minute and are gradually increased to a maximum of (usually) three or (sometimes) four minutes. It is most important that the end of the quartz rod is passed over the epiglottis, otherwise a serious burn, which develops into an ulcer, may result. The main effects of this treatmen are that it (1) reduces edema (2) clears secondary infections and (3) sometimes heals ulcers. Some cases require as many as forty exposures, at three day intervals, before the desired result is obtained. Of forty patients who had a full course of treatment, four were greatly improved and fourteen definitely improved; twelve, however, were no better and ten were definitely worse. In spite of the good results obtained in some cases the authors believe that it hardly is worth while to persevere with this method of treatment as other methods are available which give good results with less trouble to all concerned.

Climatic Effects on the Volume and Composition of Blood in Man. H. C. Bazett; F. W. Sunderman; J. Doupe, and J. C. Scott.

Am. J. Physiol. **129**:69 (April 1) 1940.

Exposure of an individual to environmental temperatures maintained at different levels for periods of several days is accompanied by significant changes in blood volume. These changes are found whether blood volume be measured by injection of congo red or T-1824 into the plasma or by the combination of carbon monoxide with hemoglobin. Blood volume is increased in warmth, decreased in cold. The changes are associated with those in the same direction both in the total circulating hemoglobin and in the total plasma protein so that at acclimatization there is little alteration in their concentrations. The changes in plasma volume develop more rapidly than those in the cells and the initial ones in blood volume are consequently associated with temporary changes in the opposite direction in hemoglobin concentration and hematocrit and sometimes also in the plasma protein concentrations.

The Electrical Excitability of Mammalian Striated Muscle. A Rosenblueth.

Am. J. Physiol. **129**:22 (April 1) 1940.

The electric responses of muscles stimulated directly are readily distinguished by their promptness from the responses elicited by indirect stimulation in which the neuromuscular delay causes a lag. The electrical excitability of innervated muscles stimulated directly could thus be studied independently of that of the corresponding nerve fibers. The electrical excitability of both nerve and muscle decreased after some minutes (20 to 60) of repetitive stimulation. This decrease took place whether (frequency 60 per second) or not (frequency 30 per second) neuromuscular transmission fatigue developed. The phenomena were reversible. No significant change of muscular excitability was found when prolonged stimulation at 60 per second led to the appearance of renewed transmission following fatigue.

Complete curarization could occur without any change of the muscular electrical excitability. Curare, however, could cause a decrease of excitability. Although prostigmin per se did not modify the muscular excitability it could cause an increase if injected after curare. While the responses of muscles to single nerve volleys were repetitive after prostigmin, those to direct stimulation were single. The electrical theory of neuromuscular transmission fails to explain the 4th and 5th stages, the block of transmission produced by curare and the repetitive character of the responses to nerve volleys after prostigmin.

Refractory Rickets. Harry Bakwin; Oscar Bodansky, and Richard Schorr.

Am. J. Dis. Child. **59**:560 (March) 1940.

The authors point out that the curative effect of vitamin D or ultraviolet irradiation on rickets in infants is one of the most constant phenomena in pediatrics. In infants with tetany, for whom the influence of treatment on the serum calcium can be readily measured, the rise in the serum level after adequate doses of viosterol or ultraviolet irradiation occurs at a fairly regular rate of about 0.4 mg. per day. After the second year of life the effect of antirachitic therapy is much less constant. The amounts necessary for cure are often considerably larger than during infancy, and the rate of healing is much slower. However, cases in which extremely large amounts of vitamin D are necessary for cure, are extremely rare.

Standardization of Temperature Regulatory Responses of Dogs to Cold. Allan Hemingway.

Am. J. Physiol. **128**:736 (March 1) 1940.

Hemingway trained unanesthetized dogs so that they could be slowly cooled by resting in a cool but not uncomfortable environment of 22.0 ± 0.5 C., humidity 50 ± per cent and an air velocity of 25 to 40 feet per minute. Respira-

tory rate and shivering movements were measured together with rectal temperatures and skin temperatures on the thorax, foreleg, ear, and beneath two diathermy electrodes, one above and the other below the recumbent dog. After vasoconstriction and shivering had occurred, the dogs were warmed by diathermy applied at a heating rate equal to the b.m.r.

New Ultraviolet Lamp for Cataract Surgery. Eliott B. Hague.

Am. J. Ophthal. **23**:317 (March) 1940.

The ultraviolet spectrum covers an extensive range. It has been conclusively shown that only the far ultraviolet rays are biologically harmful. Well separated from the abiotic wave lengths, and just beyond the visible spectrum, there is a relatively narrow band of ultraviolet light which, if directed into the eye, will cause the lens to fluoresce. In 1938 the author suggested to Hildreth the possibility of utilizing a relatively new source of ultraviolet light, a new type of mercury-vapor lamp. Since that time Hague worked out a method of ultraviolet illumination of the anterior segment and the lens, using a mercury-vapor lamp and filter chosen for transmission characteristics, availability, safety, and adaptability to manipulation. This lamp, which was developed in cooperation with the Scientific Research Departments of the American Optical and Spencer Lens Companies, will soon be available for general use.

Common Rheumatism and Physiotherapy. M. Gutstein.

Brit. J. Phys. Med. **3**:46 (March) 1940.

Any muscle or tendon of the body may give rise to rheumatic complaints. But it is correct to say that there exist certain muscles which are most commonly diseased. Physical therapy gives excellent results. In the last five years infra-red rays have been used by Gutstein almost exclusively, a 100 watt generator being used. An application of 15 to 30 minutes' duration is given three times a week or even daily. It is necessary to stress the point to the myalgic spots, ascertained by a careful examination, and not to an area described as painful by the patient himself. During treatment the lamp must be placed parallel to the affected muscle so that the rays are falling at a right angle on the affected part. The irradiation is followed by a strictly local massage confined to the myalgic spots. In most cases the myalgic areas show a hard consistency, and appreciable pressure is often needed to break them up and bring them back to normal condition.

Grenz-Ray Treatment of Experimental Infection of Cornea. Edward Gallardo; Raymond Pfeiffer, and Richard Thompson.

Am. J. Ophthal. **23**:41 (Jan.) 1940.

The clinical value of Grenz rays in the treatment of inflammatory diseases of the cornea has been demonstrated by a number of workers. These rays are effective in the superficial tissues in which they are absorbed and are especially adapted to treatment of surface lesions of the eye. Lesions and resulting scars produced by intracorneal injections of staphylococci in rabbits were consistently smaller in eyes treated by repeated applications of Grenz rays following the infection than those in the untreated eyes of the same animals.

The mechanism by which this form of radiant energy stimulates healing is not understood. In a previous paper the authors reported that the local formation of precipitins following the injection of egg albumen into the rabbit's cornea was increased by exposure of the cornea to repeated dosages of Grenz rays. The effect was most marked when the exposures were made for several days prior to the injection of antigen. The failure to produce evidence of protection in the first experiment in which treatments were given in such a way as previously found to stimulate antibody formation in the cornea (that is for several days before the intracorneal injections) seems to indicate that the rays did not affect the lesions by the stimulation of antibodies against the organisms. In a few preliminary experiments the Grenz rays were found to be bactericidal for staphylococci on the surface of agar plates. Whether these rays are able to kill or injure bacteria within the corneal tissue is a possibility yet unproved.